ROLLS-ROYCE TRANSMITTALS

'The introduction of any amendment or revision not certified in accordance with British Civil Airworthiness Requirements, Chapter A6-2, will invalidate the statement of certification at the front of this manual

Amendments or revisions embodied in this manual which have been certified under an approval authorization other than that applicable to the initial certification must be recorded on separate record sheets'.

Transmittal		Inserted by	Transmittal		Inserted by	Transmittal		Inserted by	Transmittal		Inserted by
No.	Date		No.	Date		No.	Date		No.	Date	
1 to 95 incorporated						158	5/9/72	JHH	190	1-31-78	WB
96	INC.	RR	129	4/29/69	J. J.	159	5/9/72	JHH	191	3-31-79	Ctm
97	INC	RR	130	4/29/69	J. J.	160	6/13/72	RFW	192	10-4-78	Ctm
98	INC	RR	131	6/8/69	J. J.	161	6/21/72	RFW	193	10-4-78	Ctm
99	INC	RR	132	6/18/69	J. J.	162	8/3/72	RFW	194	11-2-78	EC
100-103	INC.	RR	133	8/22/69	J. J.	163	9/28/72	RFW	195	1/26/79	Ctm
			134	8/22/69	J. J.	164	1/19/73	RFW	196	11/5/79	Ctm
			135	8/22/69	Frankie	165	2/27/73	RFW	197	11/5/79	Ctm
			136	3-10-70	Linda	166	4/27/73	RFW	198	11/5/79	
107	1-31-67	VC	138	"	"	167	7/30/73	RFW			
108	3-24-67	VC	139	"	"	168	9/6/73	RFW			
109	4-17-67	VC	137	3-12-70	Linda	169	2/18/74	WB			
110	5-26-67	VC	138	3/10/70	"	170	6/21/74	WB			
110	8-2-67	VC	139	3/11/70	"	171	6/21/74	WB			
			140	9-17-70	Linda	172	8/7/74	SW			
112	9-12-67	VC	141	"	"	173	8/7/74	SW			
113	10-9-67	VC	142	9-17-70	Linda	174	10/3/74	RFW			
114	10-9-67	VC	143	"	"	175	10/3/74	RFW			
115	11-13-67	VC	144	"	"	176	12/30/74	WB			
116	2-23-68	VC	145	"	"	177	2/19/75	WB			
117	5-2-68	VC	146	"	"	178	4/22/75	WB			
118	7-68	VC	147	2-12-71	Linda	179	7/4/75	WB			
119	8-68	VC	148	"	"	180	9/4/75	WB			
120	7-68	VC	149	"	"	181	9/13/76	WB			
121	[illegible]	VC	150	"	"	182	9/13/76	WB			
122	[illegible]	VC	151	9-16-71	Linda	183	9/13/76	WB			
123	11-68	VC	152	"	"	184	9/13/76	WB			
124	1-17-69	J. J.	153	"	"	185	9/13/76	WB			
125	3/27/69	J. J.	154	"	"	186	9/13/76	WB			
126	3/27/69	J. J.	155	11-4-71	Linda	187	11/1/76	WB			
127	3/27/69	J. J.	156	5/9/72	JHH	188	12/13/77	WB			
128	4/29/69	J. J.	157	5/9/72	JHH	189	12/13/77	WB			

continued

Temporary

Transmittal		Inserted by	Transmittal		Inserted by	Transmittal		Inserted by	Transmittal		Inserted by
No.	Date		No.	Date		No.	Date		No.	Date	
72-5	1-13-67	TC									
89-2	1-13-67	TC									
~~89-3~~	~~1-31-67~~	~~TC~~									
72-6	6-23-67	TC									
72-7	6-23-67	TC									
89-4	6-23-67	TC									
71-6	2-27-68	TC									
71-8	5-68	TC									
			233	2/85	pm						
			234	4/85	pm						

ROLLS-ROYCE LIMITED

EAST KILBRIDE

TELEGRAMS - 'AEROFAC' GLASGOW
TELEX - 778432
TELEPHONE - EAST KILBRIDE 20200

The Rolls-Royce originated contents of this transmittal comply with British Civil Airworthiness Requirements, Section A, Chapter A6-2

Signed Dutton

Date Apr.4/85

CAA Approval No. DAI/1801/45

MAINTENANCE MANUAL FOR ROLLS-ROYCE DART ENGINES

Publication Ref.M-Da7-F

TRANSMITTAL LETTER No.234

Before incorporating this transmittal letter check that all previous transmittal letters have been incorporated

	Remove:	Incorporate:	Reason for change:
Chapter 5			
5-1	Pages 3,4 and 5.	Pages 3,4 and 5/6 dated Apr.85.	'Maximum approved lives - Group 'A' parts' - Effect of Mod.1850,1848 and 1510.

Record the number of this transmittal letter and date of incorporation on the Record of Revisions.

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Signed Dutton

Date Feb.7/85

CAA Approval No. DAI/1801/45

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Publication Ref.M-Da7-F

TRANSMITTAL LETTER No.233

Before incorporating this transmittal letter check that all previous transmittal letters have been incorporated

	Remove:	Incorporate:	Reason for change:
Chapter 76	Pages 1/2.	Pages 1/2 dated Jan.85.	'List of effective pages' - Normal update.
76-0	Page 211.	Page 211 dated Jan.85.	'Engine controls - Maintenance practices' - Control adjustment at Maximum dry power was insufficient on Mk.528-7E engines incorporating Mod.1850.

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Signed R A Townsend Date Oct.12/79 CAA Approval No. DA1/1801/45

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Publication Ref.M-Da7-F

TRANSMITTAL LETTER No.198

Before incorporating this transmittal letter check that all previous transmittal letters have been incorporated

	Remove:	Incorporate:	Reason for change:
Chapter 72			
72-3	Pages 201,202, 202A and 202B	Pages 201,202, 202A and 202B dated July 79.	'Compressor - Maintenance practices' - To amend compressor crack limits.
72-5	Page 204	Page 204 dated Aug.79	'Combustion section - Maintenance practices' - Correct a typographical error.
Chapter 77			
77-2-1	Pages 215,217, 218,220 and 221	Pages 215,217, 218,220 and 221 dated Aug.79	'Thermocouples and harness - Maintenance practices' - T.G.T. Indicator set point altered from 740 deg.C. to 860 deg.C. at the Aircraft Manufacturers' request.
Chapter 89	Contents pages 1/2	Contents pages 1/2 dated July 79.	'Standard practices - Engine' - To include a new section and title.
89-1	Page 2C	Page 2C dated July 79	'Servicing and storage materials' - To update grease specification and include additional approved brand names.
89-1	Pages 7,8 and 9/10	New pages 7/8 and 9 to 12 dated July 79.	'Servicing and storage materials' - To incorporate marking materials and amend a manufacturer's address.

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	Remove:	Incorporate:	Reason for change:
Chapter 89			
89-17	-	Page 1 dated July 79.	'Temporary marking of parts' - First issue.

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Signed R A Townsend Date May 31/79 CAA Approval No. DA1/1801/45

MAINTENANCE MANUAL FOR ROLLS-ROYCE DART ENGINES

Publication Ref.M-Da7-F

TRANSMITTAL LETTER No.197

Before incorporating this transmittal letter check that all previous transmittal letters have been incorporated

	Remove:	Incorporate:	Reason for change:
Chapter 71			
71	Pages 1 and 2	Pages 1 and 2 dated May 79	'List of Effective Pages' - Normal update
71-0	Pages 551/1, 571/1 and 581/1	Pages 551/1,571/1 and 581/1 dated May 79.	'Power plant - Adjustment/ test' - To indicate that cable length is not mandatory.
Chapter 89			
89-4	Pages 1,2A/2B, 3 and 4	Pages 1,2A/2B,3 and 4 dated May 79.	'Engine inspection periods' - To update inspection requirements.

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Signed RATownsend Date Mar.30/79 CAA Approval No. DA1/1801/45

MAINTENANCE MANUAL FOR ROLLS-ROYCE DART ENGINES

Publication Ref.M-Da7-F

TRANSMITTAL LETTER No.196

Before incorporating this transmittal letter check that all previous transmittal letters have been incorporated

	Remove:	Incorporate:	Reason for change:
Chapter 71	Pages 1 and 2	Pages 1 and 2 dated Mar.79	'List of Effective Pages' - Normal update.
71-0	Pages: 101,104 105,108,115,117, 119,120,120A/ 120B,124,126, 129 to 131,134 to 136,137 to 143.	Pages: 101,104, 105,108,115,117, 119,120,120A/ 120B,124,new pages 124A/124B, page 126, new pages 126A/126B, pages 129 to 131, 134 to 136 and 137 to 143 dated Mar.79	'Power plant - Trouble shooting' - 1. To delete reference to Chart 1. 2. To expand cross references. 3. Editorial alterations.
	Pages:541/13/14, 541/19/20, 581/8C/8D,and 581/16.	Pages:541/13/14, 541/19/20, 581/8C/8D and 581/16 dated Mar.79	'Power plant - Adjustment/ test' - 1. To expand cross references. 2. To instruct T.G.T. acceptance limits following combustion chamber or flame tube replacement. 3. Reference to Data-plate T.G.T. was incorrect.

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	Remove:	Incorporate:	Reason for change:
Chapter 72			
72-5	Pages 211,212, and 215 to 218	Pages 211,212, and 215 to 218 dated Mar.79	'Combustion section - Maintenance practices' - 1. To clarify ground-run procedures. 2. Effect of Mod.1731 3. Editorial changes.
72-6	Pages 205 and 206.	New pages 202A to 202D and pages 205 and 206 dated Mar.79	'Turbine and nozzle box - Maintenance practices' - Effect of Mod.1674.
Chapter 73			
73-3	Page 205	Page 205 dated Mar.79	'Fuel control unit - Maintenance practices' - To correct an erroneous statement.
Chapter 89			
89-1	Pages 2,2A,2C/ 2D and 3 to 9/10	Pages 2,2A,2C, 2D and 3 to 9/10 dated Mar.79	'Servicing and storage materials' - 1. To include revised list of corrosion inhibitor/ lubricity aids. 2. To include materials required for anti-corrosion treatment of air casings. 3. To revise list of manufacturers and suppliers.

Record the number of this transmittal letter and date of incorporation on the Record of Revisions.

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Signed R A Townsend Date Jan.8/79 CAA Approval No. DA1/1801/45

MAINTENANCE MANUAL FOR ROLLS-ROYCE DART ENGINES

Publication Ref.M-Da7-F

TRANSMITTAL LETTER No.195

Before incorporating this transmittal letter check that all previous transmittal letters have been incorporated

	Remove:	Incorporate:	Reason for change:
Chapter 73			
73-0	Page 204	Page 204 and new pages 204A/204B dated Nov.78	'Engine fuel and control - Maintenance practices'- Correction factors for burner pressure/idling fuel flow check amplified.
73-1	Pages 201,202 and 203	Pages 201,202 new pages 202A/202B and page 203 dated Nov.78	'Fuel burners - Maintenance practices' - 1. To clarify and rationalise fuel burner cleaning procedures. 2. To introduce LIX400 and its alternative Turco 5884 as cleaning agents for fuel washed burners 3. WARNINGS are introduced to list precautions to be taken when LIX400 or Turco 5884 is to be used. 4. CAUTIONS are introduced to: (a) Emphasise that LIX400 and Turco 5884 should be filtered before mixing with Butyl Cellusolve (b) Instruct that both solvents have an adverse effect on rubber. 5. Editorial alterations.
Chapter 82	Page 1	New pages 1/2 dated Nov.78	'List of effective pages'- Normal update.

Continued..........................

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	Remove:	Incorporate:	Reason for change:
Chapter 82 82-1	Pages 207 208,211 and 212	Pages 207,208, 211 and 212 dated Nov.78	'Water/methanol control unit' Maintenance practices - 1. Effect of Mod.1588 2. To correct erroneous cross references.
Chapter 89 89-1	Pages 3,4 and 9/10	Pages 3,4 and 9/10 dated Nov.78	'Servicing and storage materials' - 1. Applicability of jointing compound expanded to cover water/methanol control unit servo cylinder cover faces and oil relief valve. 2. To introduce LIX400 and its alternative Turco 5884 as cleaning agents for fuel washed burners, 3. To instruct that '14/25 Turco Softblast' is the only approved grit for cleaning Dart compressors.

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The Rolls-Royce originated contents of this transmittal comply with British Civil Airworthiness Requirements, Section A, Chapter A6—2.

Signed R A Townsend Date Aug.24/78 CAA Approval No. DA1/1801/45

MAINTENANCE MANUAL FOR ROLLS-ROYCE DART ENGINES

Publication Ref.M-Da7-F

TRANSMITTAL LETTER No.193

Before incorporating this transmittal letter check that all previous transmittal letters have been incorporated

	Remove:	Incorporate:	Reason for change:
Chapter 5			
5	Page 1	Page 1 dated July 78.	'List of Effective Pages' - Normal update
Chapter 71			
71	Pages 1 and 2	Pages 1,2 and new page 3 dated July 78.	'List of Effective Pages' - Normal update.
71-0	Pages 117,127, 128,133	Page 117,new pages 120A/120B, page 128 new pages 128A/128B page 133 new pages 136A/136B dated July.78	'Power plant - Trouble shooting'- 1. To indicate a possible cause and instruct rectification for fluctuating r.p.m. T.G.T. and torque parameters. 2. To indicate the effect on torque of a faulty combined drain valve and instruct rectification. 3. To instruct investigation and rectification of an unexplained increase in oil level. 4. To correct typographical errors.

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	Remove:	Incorporate:	Reason for change:
Chapter 71			
71-0	Pages 511/1/2, 511/3/4,511/5, 511/6,511/7, 511/9,511/10, 511/11,511/23 and 511/24 and 521/1	Pages 511/1/2, 511/3/4,511/5, 511/6,511/7, 511/9,511/10, 511/11,511/23 and 511/24,521/1 dated July 78.	'Power plant - Adjustment/test'- 1. To include engine Mk. number references which were previously omitted in error. 2. To delete a NOTE: which refers to an 'in-flight' condition. 3. To delete erroneous table numbers. 4. To correct terminology and typographical errors. 5. To include additional abbreviations. 6. 'In-Service Ground Run-Dry' instructions have been amplified. 7. To instruct the use of Potentiometer R.R. type GZ.38989. 8. To re-introduce the alternative method of adjusting turbine gas temperature, which was previously deleted. 9. Torque pressure correction graphs amended to facilitate reading of torque pressure valves for lower torque engines. 10. Various editorial improvements.
	Pages 541/9/10 to 541/19/20.	Pages 541/9/10 to 541/19/20 dated July 78.	
	Pages 551/1, 551/2,551/2A, 551/2B,551/3/4 to 551/7/8, 551/15,and 551/19/20.	Pages 551/1, 551/2,551/2A, 551/2B,new pages 551/2C/2D,pages 551/3/4,551/5/6, new pages 551/6A/6B,pages 551/7/8, 551/15,551/19 and 551/20 dated July 78.	
	Pages 561/1 and 561/2.	Pages 561/1 and 561/2 dated July 78.	
	Pages 571/1 to 571/7/8 and 571/19/20.	Pages 571/1,571/2,new pages 571/2A,571/2B and 571/2C/2D,pages 571/3/4,571/5/6, new pages 571/6A/6B,pages 571/7/8,571/19 and 571/20 dated July 78.	

Continued ....

	Remove:	Incorporate:	Reason for change:
Chapter 71			
71-0	Pages 581/1, 581/2, 581/2A, 581/2B, 581/3/4 to 581/7/8, 581/8A/8B, 581/18, 581/19 and 581/23/24.	Pages 581/1, 581/2, 581/2A, 581/2B, new pages 581/2C, 581/2D, pages 581/3/4, 581/5/6, new pages 581/6A/6B, pages 581/7/8, 581/8A/8B, new pages 581/8C/8D and pages 581/18, 581/19, 581/23 and 581/24 dated July 78.	
	Pages 591/7/8 and 591/9/10.	Pages 591/7/8 and 591/9/10 dated July 78.	
Chapter 72			
2-1	Pages 206 and 207.	Page 206 and new pages 207/208 dated July 78.	'Engine intake cowling - Maintenance practices' - 1. To instruct the use of Adcora P6 as Boscoprene 2421 is no longer manufactured. 2. Boscoprene 2114-1 has been superseded by Boscoprene 2114-5.
Chapter 89			
9-1	Pages 6,7 and 8.	Pages 6,7 and 8 dated July 78.	'Servicing and storage materials' - 1. To instruct the use of Adcora P6 as Boscoprene 2421 is no longer manufactured. 2. Boscoprene 2114-1 has been superseded by Boscoprene 2114-5.

Continued ....

	Remove:	Incorporate:	Reason for change:
Chapter 89			
89-4	Pages 2A/2B	Pages 2A/2B dated July 78.	'Engine inspection periods' - To introduce an inspection of the combined drum valve.

Record the number of this transmittal letter and date of incorporation on the Record of Revisions.

ROLLS-ROYCE LIMITED
AERO DIVISION — EAST KILBRIDE
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Signed R A Townsend Date June.29/78 CAA Approval No. DA1/1801/45

MAINTENANCE MANUAL FOR ROLLS-ROYCE DART ENGINES

Publication Ref.M-Da7-F

TRANSMITTAL LETTER No.192

Before incorporating this transmittal letter check that all previous transmittal letters have been incorporated

	Remove:	Incorporate:	Reason for change:
Chapter 5			
5-1	Page 1	Page 1 dated May.78	'Maximum approved lives - Group 'A' parts' - The 'Introduction' required clarification.
Chapter 71	Page 1	Page 1 dated June.78	'List of Effective pages'- Normal update.
71-0	Page 127	Page 127 dated June.78	'Power plant - Trouble shooting' - To introduce a further high torque symptom.
Chapter 72			
72-0	Pages 702 and 702A	Pages 702 and 702A dated June.78	'Power plant - Cleaning/painting/preservation' - To correct typographical errors.
Chapter 76			
76-0	Pages 205 and 206	Pages 205 and 206 dated May.78	'Engine controls - Maintenance practices' - 1. To include Fig.numbers which were omitted in error. 2. Effect of Mod.1706.
Chapter 77			
77-2-1	Pages 207, 208 and 213 to 222	Pages 207,208 and 213 to 221 dated June.78	'Thermocouples and harness Maintenance practices' - 1. As the Sangamo Weston pyrometer test set does not qualify as Rolls-Royce recommended test equipment,it has been deleted.

Continued.........................

	Remove:	Incorporate:	Reason for change:
			2. To instruct the use of potentiometer R.R. type GZ 38989 3. To instruct the use of insulation tester AVO 8 R.R.No. ERE 1147 which replaces the Series III megger.
Chapter 89	Contents pages 1/2	Contents pages 1/2 dated June.78	'Standard practices - Engine' - To include a new section and title.
89-16	-	New page 1 dated May.78	'Misuse of molybdenum disulphide lubricants'- First issue.

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Signed R A Townsend Date Mar.29/78 CAA Approval No. DA1/1801/45

MAINTENANCE MANUAL FOR ROLLS-ROYCE DART ENGINES

Publication Ref.M-Da7-F

TRANSMITTAL LETTER No.191

Before incorporating this transmittal letter check that all previous transmittal letters have been incorporated

	Remove:	Incorporate:	Reason for change:
Chapter 72			
72-5	Page 205	Page 205 dated Mar.78	'Combustion section - Maintenance practices'- To avoid the possibility of an expansion chamber link bolt at No.4 position becoming detached swinging outboard and fouling the throttle linkage.

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Signed RATownsend Date Jan 13/78 CAA Approval No. DA1/1801/45

MAINTENANCE MANUAL FOR ROLLS-ROYCE DART ENGINES

Publication Ref. M-Da7-F

TRANSMITTAL LETTER No. 190

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	Remove:	Incorporate:	Reason for change:
Chapter 89			
89-6	Pages 3 and 4	Pages 3 and 4 dated Aug.77	'Rubber and synthetic rubber parts - Shelf life storage and inspection'- To include latest specifications.

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Signed R A Townsend Date Nov.17/77 CAA Approval No. DA1/1801/45

MAINTENANCE MANUAL FOR ROLLS-ROYCE DART ENGINES

Publication Ref.M-Da7-F

TRANSMITTAL LETTER No.189

Before incorporating this transmittal letter check that all previous transmittal letters have been incorporated

	Remove:	Incorporate:	Reason for change:
Chapter 72			
72-5	Pages 218, 219 and 220	Page 218 dated Oct.77	'Combustion section' - Maintenance practices - Effect of Alert Service Bulletin Da72-A413 and Service Bulletin Da72-420.
Chapter 89			
89-4	Page 5/6	Page 5/6 dated Oct.77	'Engine inspection periods - Recommended routine inspections'- Effect of Alert Service Bulletin Da72-A413 and Service Bulletin Da72-420.

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The Rolls Royce originated contents of this transmittal comply with British Civil Airworthiness Requirements, Section A, Chapter A6 - 2.

Signed R A Townsend Date Oct.20/78 CAA Approval No. DA1/1801/45

MAINTENANCE MANUAL FOR ROLLS-ROYCE DART ENGINES

Publication Ref.M-Da7-F

TRANSMITTAL LETTER No.194

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	Remove:	Incorporate:	Reason for change:
Chapter 71			
71	Pages 1 and 2	Pages 1 and 2 dated Oct.78	'List of Effective Pages' - Normal update.
71-0	Pages 511/23, 531/34,531/35 531/1,541/7 and 541/8	Pages 511/23, 521/34,521/35 531/1,541/7 and 541/8 dated Oct.78	'Power plant - Adjustment/ test' - 1. To instruct that if the engine oil tank contents are allowed to fall below 4 pints from full it will adversely affect torque presssure and oil pressure. 2. Page block number incorrect 3. To advise cross reference to Aircraft Manufacturers manuals before using 'ENGINE STARTING,MOTORING AND STOPPING DRILLS'
Chapter 73			
73-3	Page 205	Page 205 dated Oct.78	'Fuel control unit - Maintenance practices' - Existing instructions for control interconnection following an F.C.U. change on a low life engine do not preclude the possibility of raising the corrected torque pressure above the torque pressure upper limit.
Chapter 89			
89-1	Page 6	Page 6 dated Oct.78	'Servicing and storage materials' - To correct a typographical error.

Record the number of this transmittal letter and date of incorporation on the Record of Revisions.

RETAIN THIS LETT[illegible] [illegible] HECK THA[illegible] ALL [illegible] TRAN[illegible] HAVE [illegible] ED
If any have not been receive[illegible] please advise Te[illegible]nical Publications Department, Ro[illegible]-Roy[illegible] L[illegible] [illegible] PY

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Signed John R Hutter   Date Dec.10/76   C.A.A. Approval No. DAI/1801/45

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MAINTENANCE MANUAL FOR ROLLS-ROYCE DART ENGINES

Publication Ref.M-Da7-F

TRANSMITTAL LETTER No 188

Before incorporating this transmittal letter check that all previous transmittal letters have been incorporated

	Remove:	Incorporate:	Reason for change:
Chapter 89			
89-4	Pages 5/6	Pages 5/6 dated Nov 76.	'Engine inspection periods' - Because of the complexity of the new inspection periods, reference to the appropriate service bulletins is included.

Record the number of this transmittal letter and date of incorporation on the Record of Revisions.

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Signed John R Nutter Date Oct.21/76 C A A Approval No. DAI/1801/45

MAINTENANCE MANUAL FOR ROLLS-ROYCE DART ENGINES

Publication Ref.M-Da7-F

TRANSMITTAL LETTER No. 187

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	Remove:	Incorporate:	Reason for change:
Chapter 71			
71-0	Pages 541/3, 541/15/16 and 581/2B	Pages 541/3, 541/15/16 and 581/2B dated Oct. 76.	'Power plant - Adjustment/test' - 1. It is no longer necessary to carry out a pre-removal ground run prior to removal of a propeller. 2. To correct an ambiguous statement and a typographical error.
Chapter 89			
89-1	Page 2	Page 2 dated Sept. 76.	'Servicing and storage materials' - To include an additional anti-corrosion additive.

Record the number of this transmittal letter and date of incorporation on the Record of Revisions.

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This permanent revision/amendment complies with British Civil Airworthiness Requirements, Section A, Chapter A6-2

Signed John R Nutter. Date Aug.26/76 C A A Approval No. DAI/1801/45

MAINTENANCE MANUAL FOR ROLLS-ROYCE DART ENGINES

Publication Ref M-Da7-F

TRANSMITTAL LETTER No.186

Before incorporating this transmittal letter check that all previous transmittal letters have been incorporated

	Remove:	Incorporate:	Reason for change:
Chapter 71	-	New pages 1 and 2 dated June 76.	'List of effective pages' - Introduction of list of effective pages.
71-0	Table of contents page 101	Table of contents page 1 dated June 76.	'Power plant - Trouble shooting' - 1. Existing instructions did not reflect current experience. 2. To introduce instructions which will facilitate 'On The Wing' redeclaration of engine torque pressures. 3. Cross-references to other areas of the manual required amplification.
71-0	Pages 102, 102A/B, 103,104, 104A,104B, 104C/D,105, 106,106A/B, Temporary revision dated Feb. 10/68 facing page 107, pages 107, 108,108A, 108B,108C, 108D,108E, 109,110, 110A,110B, 111,112 and 113	Pages 101 to 113 and new pages 114 to 143 dated June 76.	

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	Remove	Incorporate:	Reason for change:
71-0	Table of contents pages 501, 502 and 503	New tabbed divider card 'Adjustment/test' and table of contents pages 501 and 502 dated June 76	'Power plant - Adjustment/test' - 1 Method of determining the Mintorque amplified 2 Engine handling instructions did not reflect current experience 3 Introduction of check lists to enable the ground engineers to determine the correct checks required during a particular ground run. 4 Inclusion of tabbed divider cards to facilitate the locating of the various Sections and Sub-sections in this chapter 5 To rationalize the sequence of the checks detailed in the various ground runs. 6 To instruct the use of a potentiometer during certain ground runs 7 Deletion of the alternative method of adjusting turbine gas temperature 8 To include additional abbreviations 9 Editorial improvements
	Pages 503/1 and 503/2	Pages 503/1 and 503/2 dated June 76	
	Divider page '1 Engine Handling pages 511/1, 511/2, 511/2A/2B, 511/3 to 511/10, 511/10A/10B and 511/11 to 511/13	New tabbed divider card '1 Engine Handling', pages 511/1/2 to 511/13/14 and new pages 511/15 to 511/24 dated June 76	
	Divider page '2 Propeller System Functional Checks', pages 521/1 to 521/26, 521/26A, 521/26B and 521/27 to 521/34	New tabbed divider card '2 Propeller System Functional Checks', pages 521/1 to 521/34 and new pages 521/35 to 521/48 dated June 76	

Continued . . . .

Remove:	Incorporate:	Reason for change:
Divider page '3 Engine Starting, Motoring and Stopping Drills' and pages 531/1 to 531/11	New tabbed divider card '3 Engine Starting, Motoring and Stopping Drills', pages 531/1 to 531/11/12 and new pages 531/13 to 531/20 dated June 76	
Divider page '4 Engine Ground Running Procedures', pages 541/1, 541/2, 541/2A/2B and 541/3 to 541/10	New tabbed divider card '4 Engine Ground Running Procedures', pages 541/1 to 541/9/10 and new pages 541/11/12 to 541/19/20 dated June 76	
Divider page 'A Installation Ground Run - Dry', pages 551/1 to 551/14, 551/14A, 551/15 to 551/21, 551/21A and 551/23 to 551/25	New tabbed divider card '4A Installation Ground Run - Dry', pages 551/1, 551/2, new pages 551/2A and 551/2B and pages 551/3/4 to 551/19/20 dated June 76.	
Divider page 'B Ground Run - Wet' and pages 561/1 to 561/5/6	New tabbed divider card '4B Ground Run - Wet' and pages 561/1 to 561/5/6 dated June 76	

Continued

Remove.	Incorporate	Reason for change:
Divider page 'C In-Service Ground Run - Dry', pages 571/1 to 571/7, 571/8A/8B, 571/9 to 571/14, 571/14A, 571/15 to 571/21, 571/21A and 571/23 to 571/25	New tabbed divider card '4C In-Service Ground Run - Dry' and pages 571/1 to 571/19/20 dated June 76	
Divider page 'D Removal and Re-Installation Ground Runs - Dry', pages 581/1,581/2, 581/2A,581/3 to 581/14, 581/14A, 581/15,581/16, 581/16A/16B, 581/17 to 581/23, 581/23A and 581/25 to 581/27	New tabbed divider card '4D Removal/Re-Installation Ground Runs - Dry', pages 581/1,581/2, 581/2A, new page 581/2B, pages 581/3/4 to 581/7/8, 581/8A/8B and 581/9/10 to 581/23/24 dated June 76	
Divider page 'E Charts' and pages 591/1 to 591/9/10	New tabbed divider card '4E Charts', pages 591/1 to 591/9/10 and new pages 591/11/12 to 591/21/22 dated June 76.	

Continued

	Remove:	Incorporate:	Reason for change:
Chapter 72			
72-5	Page 202	Page 202 dated May 76	'Combustion section' - Maintenance practices - Effect of Mod 1632.
Chapter 73			
73-3	Pages 201 to 205	Pages 201 to 205 and new page 206 dated June 76	'Fuel control unit - Maintenance practices' - 1 CAUTION required amplification 2 Reference to relevant actions and ground runs. 3 To establish a datum T.G.T. when an engine cannot be run prior to an F.C.U. change.
Chapter 76			
76-0	Pages 206, 206A/206B, 207,211, 213,214 and 215/216	Pages 206, 206A/206B, 207,211,213, 214 and 215/216 dated June 76	'Engine controls - Maintenance practices' - 1 Introduction of Mk.536-7R engines 2 Amplification of control static checks 3. To correct a typographical error
Chapter 82	Page 1	Page 1 dated June 76.	'List of effective pages' - Normal update.
82-1	Page 209	Page 209 and new pages 210, 211 and 212 dated June 76	'Water/methanol control unit - Maintenance practices' - To instruct renewal of the water/methanol control unit servo piston seal.

Record the number of this transmittal letter and date of incorporation on the Record of Revisions

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This permanent revision/amendment complies with British Civil Airworthiness Requirements, Section A, Chapter A6-2

Signed John R Nutter Date June 28/76 CAA Approval No. DAI/1801/45

MAINTENANCE MANUAL FOR ROLLS-ROYCE DART ENGINES

Publication Ref M-Da7-F

TRANSMITTAL LETTER No 185

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	Remove:	Incorporate:	Reason for change:
Chapter 72			
72-5	Pages 204, 205 and 206	Page 204, new pages 204A, 204B, pages 205 and 206 dated May 76.	'Combustion section' - Maintenance practices - Effect of Mod. 1632.
Chapter 89			
89-1	Page 6	Page 6 dated May 76.	'Servicing and storage materials' - Effect of Mod. 1632.

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Signed John R Nutter. Date May 10/76 C.A.A. Approval No. DAI/1801/45

MAINTENANCE MANUAL FOR ROLLS-ROYCE DART ENGINES

Publication Ref. M-Da7-F

TRANSMITTAL LETTER No. 184

Before incorporating this transmittal letter check that all previous transmittal letters have been incorporated

	Remove:	Incorporate:	Reason for change:
Chapter 89			
89-1	Page 2 and 2B	Page 2 and 2B dated Apr. 76.	'Servicing and storage materials' – 1. To include the latest issue of oil specifications. 2. To include an additional anti-corrosion additive. 3. Incorrect cross reference.

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Signed John R Nutter. Date Jan.15/76 CAA Approval No. DAI/1801/45

MAINTENANCE MANUAL FOR ROLLS-ROYCE DART ENGINES

Publication Ref.M-Da7-F

TRANSMITTAL LETTER No.183

Before incorporating this transmittal letter check that all previous transmittal letters have been incorporated

	Remove:	Incorporate:	Reason for change:
Chapter 72			
72-3	Pages 202A and 202B dated May 75.	Pages 202A and 202B dated May 75.	'Compressor - Maintenance practices' - Some Operators may have received badly printed pages.

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Signed John R Nutter   Date Nov.24/75   C A A Approval No. DAI/1801/45

MAINTENANCE MANUAL FOR ROLLS-ROYCE DART ENGINES

Publication Ref.M-Da7-F

TRANSMITTAL LETTER No.182

Before incorporating this transmittal letter check that all previous transmittal letters have been incorporated

	Remove:	Incorporate:	Reason for change:
Chapter 72			
72-5	Pages 205, 206,217 and 218	Pages 205,206, new page 206A/206B, pages 217 and 218 dated Oct. 75.	'Combustion section' - Maintenance practices - Incorrect clearances can cause gas leaks, vibrations and undue suspension pin wear.
72-6	Page 206	Page 206 dated Oct. 75.	'Turbine and nozzle box' - Maintenance practices - Incorrect clearances can cause gas leaks, vibrations and undue suspension pin wear.

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Signed John R Nutter. Date **Sep.25/75** C A A Approval No. DAI/1801/45

MAINTENANCE MANUAL FOR ROLLS-ROYCE DART ENGINES

Publication Ref. M-Da7-F

TRANSMITTAL LETTER No.181

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	Remove:	Incorporate:	Reason for change:
Chapter 89			
89-2	Pages 1 and 2	Pages 1 and 2 dated Aug. 75.	'Recording and control of the lives of group 'A' parts' - Effect of Airworthiness Notice No. 44, Issue 4 issued by the British Civil Aviation Authority.

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Signed John R Nutter.   Date July 31/75   CAA Approval No. DAI/1801/45

MAINTENANCE MANUAL FOR ROLLS-ROYCE DART ENGINES

Publication Ref. M-Da7-F

TRANSMITTAL LETTER No. 180

Before incorporating this transmittal letter check that all previous transmittal letters have been incorporated

	Remove:	Incorporate:	Reason for change:
Chapter 71			
71-0	Page 521/27	New pages 521/26A and 521/26B and page 521/27 dated June 75.	'Power plant - Adjustment/test' - 1. The introduction of Fokker service bulletin number 61-26 necessitates additional checks
	Page 561/3 dated May 31/71	-	2. Removal of page was not instructed in previous transmittal.
Chapter 72			
72-3	Pages 201, 202, temporary revision dated June 5/72 facing page 202, pages 202A, 202B, 204 and 205	Pages 201, 202, 202A, 202B, new pages 202C, 202D, 202E, 202F, 202G/202H, pages 204 and 205 dated May 75.	'Compressor - Maintenance practices' - To clarify acceptance standards and areas of compressor casings.
Chapter 89			
89-1	Page 1	Page 1 dated June 75.	'Servicing and storage materials' - 1. To include the latest issue of fuel specifications. 2. The maximum percentage by weight of Mercaptan sulphur is reduced.

Record the number of this transmittal letter and date of incorporation on the Record of Revisions.

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Signed John R Nutter. Date June 12/75 C A A Approval No. DAI/1801/48

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Publication Ref M-Da7-F

TRANSMITTAL LETTER No 179

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	Remove:	Incorporate:	Reason for change:
Chapter 71			
71-0	Contents page 503 and pages 511/2, 511/5/6, 511/7, 511/11, 541/7, 541/8, 551/1, 551/2, 551/3, 551/7, 551/11, 551/23, 551/24, 551/25, 561/1, 571/1, 571/3, 571/7, 571/11, 571/23, 571/24, 571/25, 581/2, 581/3, 581/7, 581/11, 581/25, 581/26, 581/27, 591/3, 591/4 and 591/5	Contents page 503 and pages 511/2, 511/5/6, 511/7, new pages 511/10A/10B and pages 511/11, 541/7, 541/8, 551/1, 551/2, 551/3, 551/7, 551/11, new page 551/21A and pages 551/23, 551/24, 551/25, 561/1, 561/3, 571/1, 571/3, 571/7, 571/11, new page 571/21A and pages 571/23, 571/24, 571/25, 581/2, 581/3, 581/7, 581/11, new page 581/23A and pages 581/25, 581/26, 581/27, 591/3/4, 591/5 and new pages 591/6, 591/7/8 and 591/9/10 dated Apr 75	'Power plant - Adjustment/test' - 1. Effect of Mod 1706. 2. To include instructions for the recently introduced Mk 536-7P engine. 3. Introduction of the Mk 532-7P engine for use in Fokker aircraft. 4. To correct typographical errors. 5. Suffix letter was omitted from engine Mk. numbers.

Continued ....

	Remove:	Incorporate:	Reason for change:
Chapter 76			
76-0	Temporary revision No. 76-1 dated Aug 15/68 and pages 206, 207,211, 212 and 213	Page 206, new pages 206A/206B and pages 207, 211,212,213 and new pages 214 and 215/216 dated Apr 75.	'Engine controls - Maintenance practices' - 1 To include contents of temporary revision 2 To instruct trim settings and controls clearances for the recently introduced Mk 536-7P engine 3 Effect of Mod 1706. 4. To delete references to modifications that are no longer applicable.

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Signed John R Nutter. Date Apr.10/75 CAA Approval No. DAI/1801/46

MAINTENANCE MANUAL FOR ROLLS-ROYCE DART ENGINES

Publication Ref.M-Da7-F

TRANSMITTAL LETTER No.178

Before incorporating this transmittal letter check that all previous transmittal letters have been incorporated

	Remove:	Incorporate:	Reason for change:
Chapter 72			
72-6	Pages 201 to 205/206	Pages 201 to 206 dated Feb. 75.	'Turbine and nozzle box - Maintenance practices' - To obviate incorrect assembly of discharge nozzles.

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The information contained in this transmittal complies with British Civil Airworthiness Requirements, Chapter A6-2.
The technical accuracy of this information has been verified and is certified correct.

Signed John R Nutter Date Feb.13/75 C.A.A. Design Approval No. AD/1063/45

MAINTENANCE MANUAL FOR ROLLS-ROYCE DART ENGINES

Publication Ref.M-Da7-F

TRANSMITTAL LETTER No 177

Before incorporating this transmittal letter check that all previous transmittal letters have been incorporated

	Remove:	Incorporate:	Reason for change:
Chapter 72			
72-5	Page 212	Page 212 dated Jan. 75.	'Combustion section - Maintenance practices' - To specify the correct ground-run procedure required after combustion chamber or flame tube changes.

Record the number of this transmittal letter and date of incorporation on the Record of Revisions.

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The technical accuracy of this information has been verified and is certified correct.

Signed Date **Dec. 19/74** C.A.A. Design Approval No. AD/1063/45

MAINTENANCE MANUAL FOR ROLLS-ROYCE DART ENGINES

Publication Ref M-Da7-F

TRANSMITTAL LETTER No 176

Before incorporating this transmittal letter check that all previous transmittal letters have been incorporated

	Remove:	Incorporate:	Reason for change:
Chapter 72			
72-2	Page 203	Pages 203/204 dated Nov. 74.	'Reduction gear - Maintenance practices' - To instruct the application of jointing compound.
Chapter 89			
89-1	Page 3	Page 3 dated Nov. 74.	'Servicing and storage materials' 1. Jointing compound is required to seal the threads of the propeller shaft seal retaining setscrews. 2. Cross-reference was incorrect.

Record the number of this transmittal letter and date of incorporation on the Record of Revisions.

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ROLLS-ROYCE (1971) LIMITED
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The technical accuracy of this information has been verified and is certified correct.

Signed

Date **Sept.13/74** C.A.A. Design Approval No. AD/1063/45

MAINTENANCE MANUAL FOR ROLLS-ROYCE DART ENGINES

Publication Ref.M-Da7-F

TRANSMITTAL LETTER No.175

Before incorporating this transmittal letter check that all previous transmittal letters have been incorporated

	Remove:	Incorporate:	Reason for change:
Chapter 5			
5-1	Pages 2,3 and 5	Pages 2,3 and 5 dated Sept. 74.	'Maximum approved lives - Group 'A' parts' - 1. To obviate misinterpretation of propeller shaft life. 2. Service experience indicates that the life declared for Mod.797, Mod.1455 or Mod.1676 first-stage impellers is now the finite life.

Record the number of this transmittal letter and date of incorporation on the Record of Revisions.

ROLLS - ROYCE

MAINTENANCE MANUAL

DART

528,528-7,529-7 and 532-7

in the
FOKKER AND FAIRCHILD FRIENDSHIP

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Publication ref. M-Da7-F

This manual complies with British Civil Airworthiness Requirements, Chapter A6-2
The technical accuracy of this manual has been verified and is certified as correct

Signed

Date July 15, 1960

A R B Design Approval No AD 1063 45

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PREFACE

This manual has been compiled to give a comprehensive understanding of the Dart 520 Series engine installed in the Friendship aircraft, and to contain all the information necessary for its maintenance between overhauls.

In compiling the manual, engine installation details have been avoided as they will be treated fully in the aircraft manufacturer's handbook. The propeller equipment is likewise treated at length in the aircraft or propeller manufacturer's publications and is mentioned only when it has a direct bearing on operation of the engine.

Changes to the engine will be covered in the Modifications Manual, T.S.D. 266, which will state whether maintenance is affected. Any new instructions or change of technique will be the subject of a Temporary Revision (formerly Maintenance Alteration) issued for insertion adjacent to the information affected.

Rolls-Royce Limited
Derby, England
November 1958

ROLLS-ROYCE DART AERO ENGINE
MAINTENANCE

PAI SUPPLEMENT B

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CHAPTER 5 - TIME LIMITS

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(R)	5	Sept.74

MAXIMUM APPROVED LIVES - GROUP 'A' PARTS

1. Introduction

This section details the maximum approved lives on Group 'A' parts which must not be exceeded in service.

CAUTION: IT IS POSSIBLE FOR AN ENGINE TO REACH THE MAXIMUM APPROVED LIFE OF A PART BETWEEN OVERHAULS, FOR EXAMPLE DURING AN ENGINE LIFE EXTENSION. IT IS THE OPERATOR'S RESPONSIBILITY TO ENSURE THAT THESE APPROVED LIVES ARE NOT EXCEEDED.

Information on the method of recording and controlling the lives of parts is described in Chapter 89-2 of this manual. The lives are expressed in terms of 'flights' these being based and recorded on the number of 'landings' completed by the aircraft. Certain parts may be influenced as much by the total hours they are in service as by the number of flights they complete; in such cases the life is expressed in flights and hours, whichever is completed first being the limiting factor.

Maximum approved lives - Group 'A' parts (cont.)

2. Life limits

NOTE: 1. An asterisk * against a limit denotes finite life. Lives not so marked are likely to be increased as testing and service experience permits and should not therefore be used for long term provisioning or budget purposes.

2. An impeller is definied as 'open bore processed' when:

(a) It has been stripped and anodized in the bore because blanks where not fitted during these processing operations.

(b) Blanks were fitted for the stripping process but removed prior to the anodizing process.

(c) Leakage past the blanks has occurred during either or both processes.

3. An impeller is not definied as 'open bore processed' when anodizing has been carried out during incorporation of Mod.797.

4. Lives quoted for Mod.1455 and Mod.1676 impellers, against which treble obelisks thus ††† appear, apply from the date of incorporation of the modification and this date should be recorded on impeller history cards. Operators with engines already in service, with impellers which were re-worked to Mod.1455 standard, should apply the lives quoted for Mod.1455 impellers from the date of modification.

5. For engines at present in Service with L.P. impellers which have exceeded, or could exceed, the new lives before scheduled removal, refer to Alert Service Bulletin Da72-A401.

6. Lives quoted for propeller shafts to Mod.1687 standard, against which a single obelisk thus † appears, will also apply to propeller shafts where the ball thrust bearing location diameter has been copper plated by the incorporation of D.R.S.306 prior to the introduction of Mod.1687 which now identifies this part of the scheme.

7. Engines may remain in service until the next shop visit at which the reduction gear is overhauled. At this time the propeller shaft total life should be determined, recorded and controlled in accordance with the maximum approved lives listed.

8. The quoted Mod.1687 life is the total life applicable since new irrespective of the propeller shaft life at the time the relevant D.R.S. is embodied (Mod.1687). Thus, Mod.1687 does not return the propeller shaft life to zero. On individual propeller shafts which have accumulated flights in a pre and post D.R.S. condition it is the total flights accumulated since new which must be subtracted from the Mod.1687 life to establish residual life.

Maximum approved lives - Group 'A' parts (cont.)

(9) Transfer of identical Group 'A' parts between engine Marks which have different declared flights life limitations is not encouraged, although theoretically the necessary life adjustments can be made according to the formula below. Meanwhile Rolls-Royce Limited advice should be obtained if practical considerations make such transfers essential.

$$\frac{\text{Number of flights used in original engine Mark}}{\text{Life limitations quoted for original engine Mark}} + \frac{\text{Number of flights available at new engine Mark}}{\text{Life limitations quoted for new engine Mark}} = 1$$

Refer to NOTES: (1) and (2) on page 1

Part description	Modification	Mk.551		Mk.520 to 536, 550-2 and all variants	
		Flights	Hours	Flights	Hours
1st stage impeller	Pre-Mod.797 Refer to NOTE:(5) on page 2	-	-	4,500*	-
	Mod.797 - 'open bore processed'	-	-	9,000*	-
	Mod.797	-	-	9,000*	-
	Mod.1455 (except Part 1) †††	-	-	9,000*	-
	Mod.1676 †††	-	-	9,000*	-
	-	9,000	-	-	-
	Mod.1455 (Part 1 only)	-	-	9,000*	-
	Mod.1850	-	-	9,000	-
2nd stage impeller	Pre-Mod.797	-	-	4,500*	-
	Mod.797	-	-	14,000*	-
	Mod.797 - 'open bore processed'	-	-	11,000*	-

††† Refer to NOTE: (4) on page 2

Maximum approved lives - Group 'A' parts (cont.)

Refer to NOTES: (1) and (2) on page 1

Part description	Modification	Mk.551		Mk.520 to 536,550-2 and all variants	
		Flights	Hours	Flights	Hours
2nd stage impeller (cont.)	-	9,000	-	-	-
	Mod.1455 †††	-	-	18,000*	-
	Mod.1475	-	-	17,000*	-
	Mod.1850	-	-	9,000	-
H.P. turbine disc	-	20,000*	-	20,000*	-
I.P. turbine disc	-	20,000*	-	20,000*	-
L.P. turbine disc	-	20,000*	-	20,000*	-
Air seal - H.P. turbine	Pre-Mod.644	-	-	-	1 engine life *
	Mod.644	-	1 engine life *	-	1 engine life *
	Mod.1017	16,000*	-	16,000*	-
	Mod.1848	16,000	-	16,000	-

††† Refer to NOTE: (4) on page 2

Maximum approved lives - Group 'A' parts (cont.)

Refer to NOTE: (1) on page 1

Part description	Modification or repair scheme	Engine Marks and all variants (except where stated)	
		Mk.520,525,526, 527,528,529, (except 529-8), 530,531,532, (except 532-1) 533,534,535,536, 550-2,551	Mk.529-8E,H, X, Y and Z Mk.532-1
		Flights	Flights
Propeller shaft	Pre-Mod.1510 with Mod.1687 †	20,000*	18,000*
	Pre-Mod.1510 less Mod.1687	35,000*	27,000*
	Mod.1510 with Mod.1687	35,000*	35,000*
	Mod.1510 less Mod.1687	35,000*	35,000*

† Refer to NOTES: (6), (7) and (8) on page 2

DESCRIPTION

PROPELLER SYSTEM

The propeller information given here is to explain the system in relation to the control of engine speed and temperature; the propeller and its control units are covered in detail in the manufacturer's publications.

The propeller is a hydraulically operated variable pitch unit, the oil for which is supplied from the engine high pressure system and boosted by a pressure pump in the controller unit. For feathering purposes, oil is supplied direct from the oil tank by an electrically driven feathering pump unit.

The oil feed to the Rotol propeller is by three main oil lines arranged as concentric tubes within the propeller shaft. Pitch change oil is conveyed through the inner and centre tubes to the propeller operating piston. The third (outer) oil line is used when required to withdraw a pitch stop, as described later.

In addition to the normal pitch range from fully feathered to flight fine, the propeller turbine engine requires a still finer propeller pitch to minimize the starting and ground idling load. When the aircraft is on the ground, the propeller is therefore allowed to fine off fully to the ground fine pitch stop, set at zero blade angle; this also provides a useful braking effect on landing because of the associated high windmilling drag.

To prevent the excessive drag that would result from the propeller inadvertently fining off into ground fine pitch in flight, a removable mechanical stop is incorporated within the propeller hub. This stop, set at blade angle of 20 degrees, is known as the low stop, and is withdrawn while the aircraft is on the ground by controller unit pressure oil admitted through the third oil line.

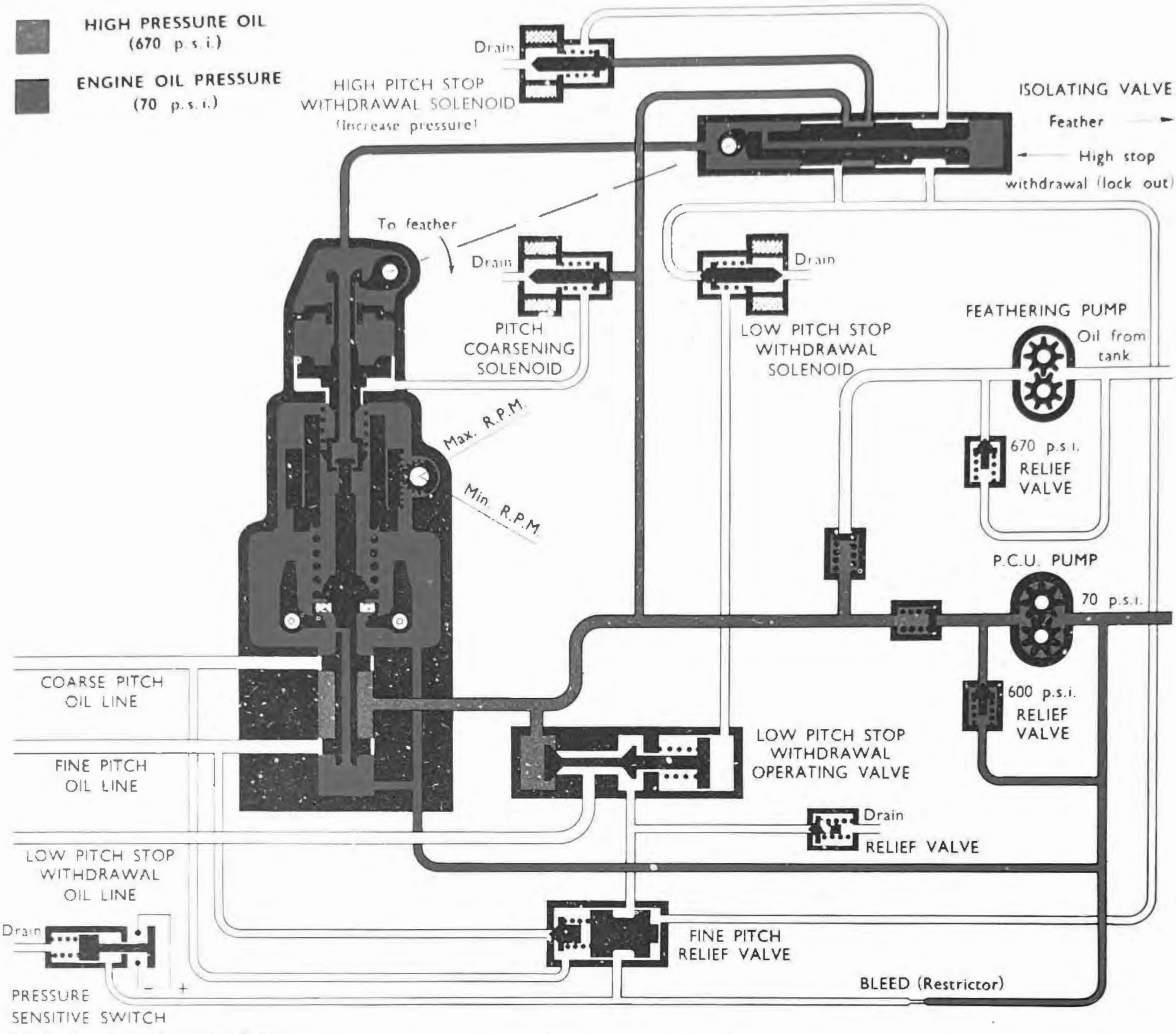
When in operation, the stop does not prevent the blades from coarsening but it does prevent them moving back into ground fine pitch once they have coarsened beyond the stop.

The propeller is also fitted with a further removable stop, the high stop, set to be effective at 32 degrees blade angle. The propeller will normally only exceed this angle and allow the stop to engage at relatively high forward aircraft speed.

When in position, the high stop safeguards against the drag and r.p.m. effects of a propeller inadvertently fining off at relatively high forward speeds; the stop is withdrawn by a build-up in oil pressure in the fine pitch oil line to the propeller, as described later.

PITCH CONTROL

The propeller controller unit (P.C.U.), mounted on the right-hand side of the engine, is driven from the engine reduction gear through the lower bevel gears. It houses a piston valve whose movement is controlled by a spring-loaded


HIGH PRESSURE OIL (670 p.s.i.)
ENGINE OIL PRESSURE (70 p.s.i.)
Drain
HIGH PITCH STOP WITHDRAWAL SOLENOID (increase pressure)
ISOLATING VALVE
Feather
High stop withdrawal (lock out)
To feather
Drain
PITCH COARSENING SOLENOID
Drain
LOW PITCH STOP WITHDRAWAL SOLENOID
FEATHERING PUMP
Oil from tank
670 p.s.i. RELIEF VALVE
Max. R.P.M.
Min. R.P.M.
P.C.U. PUMP
70 p.s.i.
600 p.s.i. RELIEF VALVE
COARSE PITCH OIL LINE
FINE PITCH OIL LINE
LOW PITCH STOP WITHDRAWAL OPERATING VALVE
Drain
RELIEF VALVE
LOW PITCH STOP WITHDRAWAL OIL LINE
Drain
FINE PITCH RELIEF VALVE
BLEED (Restrictor)
PRESSURE SENSITIVE SWITCH (High stop removed warning light)
- +

DRAWN FOR NORMAL CRUISE CONDITION

3057

Fig. 1 Propeller hydraulic system

centrifugal governor. The piston valve in a neutral position seals off the oil lines to the propeller pitch change piston in the propeller hub, so holding the blades at a given angle.

The r.p.m. at which the piston valve assumes this neutral position is determined by the loading of the governor spring; this loading is varied by a rack and pinion mechanism and an external control lever (fig. 1).

When the piston valve is raised above the neutral position, as by overspeeding of the engine and governor unit above the r.p.m. selected, high pressure oil is admitted into the coarse pitch line to the propeller until the blades have coarsened sufficiently to reduce r.p.m. to the selected value.

When the piston valve is lowered below the neutral position, as when the engine and governor unit are turning at less than the r.p.m. selected, oil is admitted into the fine pitch line to the propeller until the blades fine off sufficiently to allow the r.p.m. to rise to the selected value.

When the governor spring loading is at its minimum, it endeavours to hold the propeller speed to the minimum constant speeding r.p.m. Because of 'dead movement' built into the rack and pinion control, the minimum loading of the governor spring is unaffected by the initial advance of the r.p.m. control lever. A speed higher than the minimum constant speeding r.p.m. will not, therefore, be selected at the governor until the lever has advanced a considerable way towards the Take-off position.

If the piston valve is retained in a raised position, the governor will be overridden and the propeller will continue to coarsen, as described later under 'Electro-hydraulic stop' and 'Feathering'.

Low stop

The low stop is a removable mechanical stop whose function is to safeguard against the effect of the propeller fining off in flight below a blade angle of 20 degrees. The stop is withdrawn hydraulically, the oil supply being controlled by a double-headed valve in the propeller controller unit (fig. 1); this valve is opened in turn by oil admitted through a solenoid-operated valve. The solenoids for both propellers are energized by lifting the throttle levers from the IDLE position and pulling them rearwards against a spring. The same result can be obtained by lifting and pressing back any one throttle, provided the other is at IDLE. This action closes the manual control switches (fig. 2 or 3). Another set of switches, operated by the gust lock lever, complete an alternative circuit to energize the low stop solenoids when the lever is at the IN position.

Whenever the throttles are lifted and pulled back or the gust lock lever moved to IN, two isolating/release relays are energized which isolate the pitch coarsening circuits (described later) and complete a circuit in series with a throttle switch (closed below 14,000 r.p.m.) on each engine. This circuit provides a third method of energizing the low stop solenoids, and thus self-energizes the isolating/release relays. When the throttle levers are set at any position between IDLE and 14,000 r.p.m., this circuit holds the low stops withdrawn provided the isolating/release relays have been previously energized through either the manual control or the gust lock switches.

It is thus possible to release the gust locks (by moving the gust lock lever to OUT) and to open the throttles to any setting below 14,000 r.p.m., without allowing the low stops to engage. Movement of either or both throttles beyond 14,000 r.p.m. in this condition will break the circuit, the low stops will engage and the isolating/release relays will be de-energized. This will result in the pitch coarsening circuits becoming armed and the self-energizing contacts of the relays will open.

Since there are three different circuits for energizing the low stop solenoids, all three circuits must be broken to allow the stops to engage. This can be achieved by moving the gust lock lever to OUT and then opening a throttle to

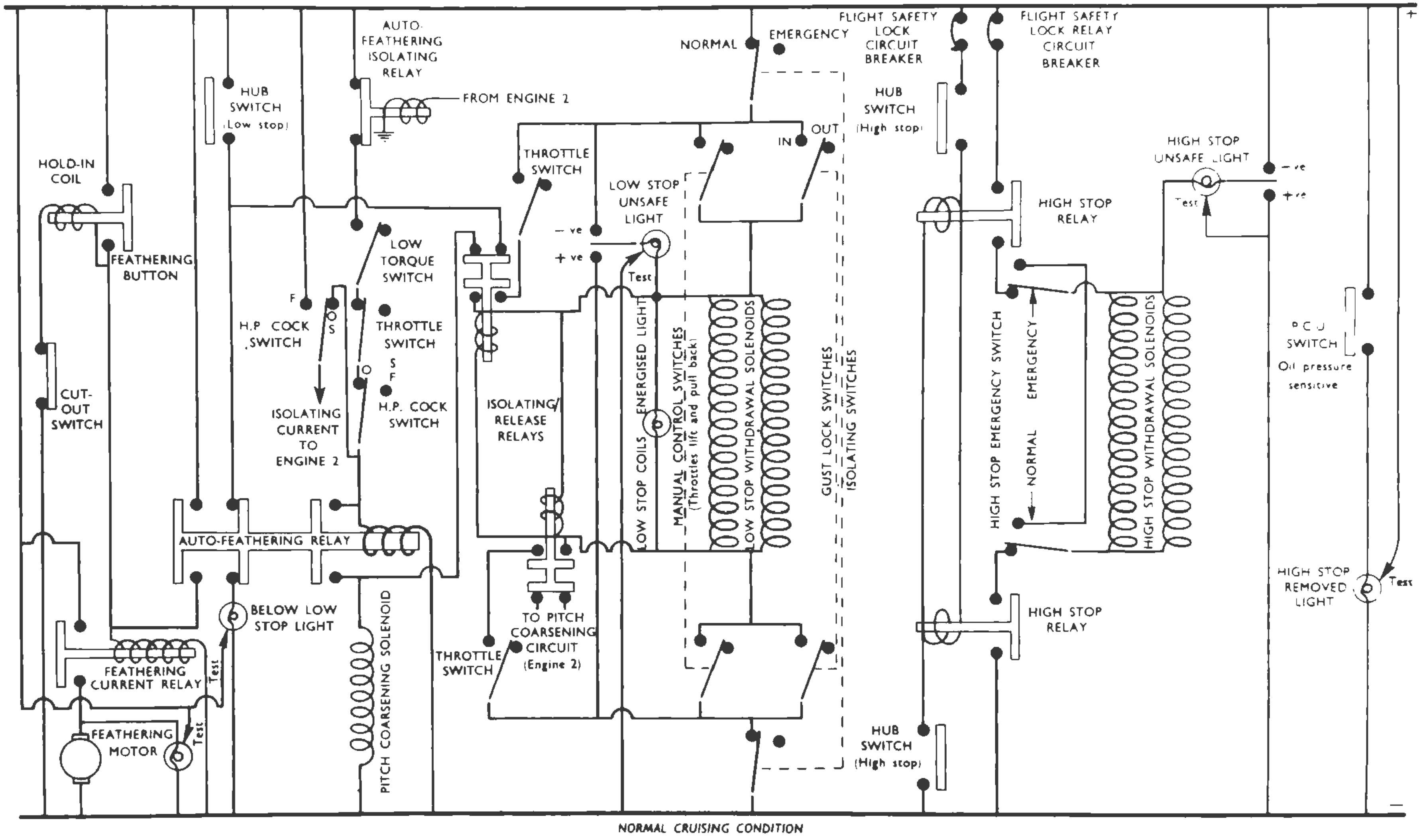


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Fig. 2 Typical Fairchild Friendship two-stop propeller control system — electrical

the TAKE-OFF position, i.e. beyond 14,000 r.p.m Returning the throttle to IDLE will not complete the low stop withdrawal circuit again because the isolating-release relays have opened.

A 'low stop coils energized' light is included in the circuit and will glow whenever the solenoids are energized.

For ground running, the flying controls gust lock lever is normally IN; this prevents the low stops being engaged on the ground, and the mechanical arrangement allows both throttles to be advanced together to 12,500 r.p.m., but only singly beyond this position.

A 'low stop unsafe' light, either wired in continuous circuit or used in conjunction with a test switch, is provided to indicate a fault should either side of the low stop circuit become 'live' while the low stops are engaged. The warning lamps themselves may be tested.

Should either the 'low stop coils energized' light or the 'low stop unsafe' light come on during flight, it will indicate that the low stops are either withdrawn or no longer double failure proof. An isolating switch is provided which when moved to the EMERGENCY position will isolate the stop withdrawal circuit during the remainder of the flight.

Electro-hydraulic stop (pitch coarsening)

Any failure in flight of the low stop would allow the propeller in certain circumstances to move into ground fine pitch. To safeguard against this happening in the air, the propeller is provided with a hub switch which is set to close whenever the blades move below the low stop angle (fig. 2 or 3).

Closing this hub switch in the air energizes a pitch coarsening solenoid which then allows high pressure oil to raise the piston valve in the P.C.U., causing the propeller to coarsen. Pitch coarsening continues only until the pitch has increased sufficiently to open the hub switch again, thereby breaking the pitch coarsening circuit. The propeller will then fine off again until the hub switch closes once more, when the cycle will be repeated.

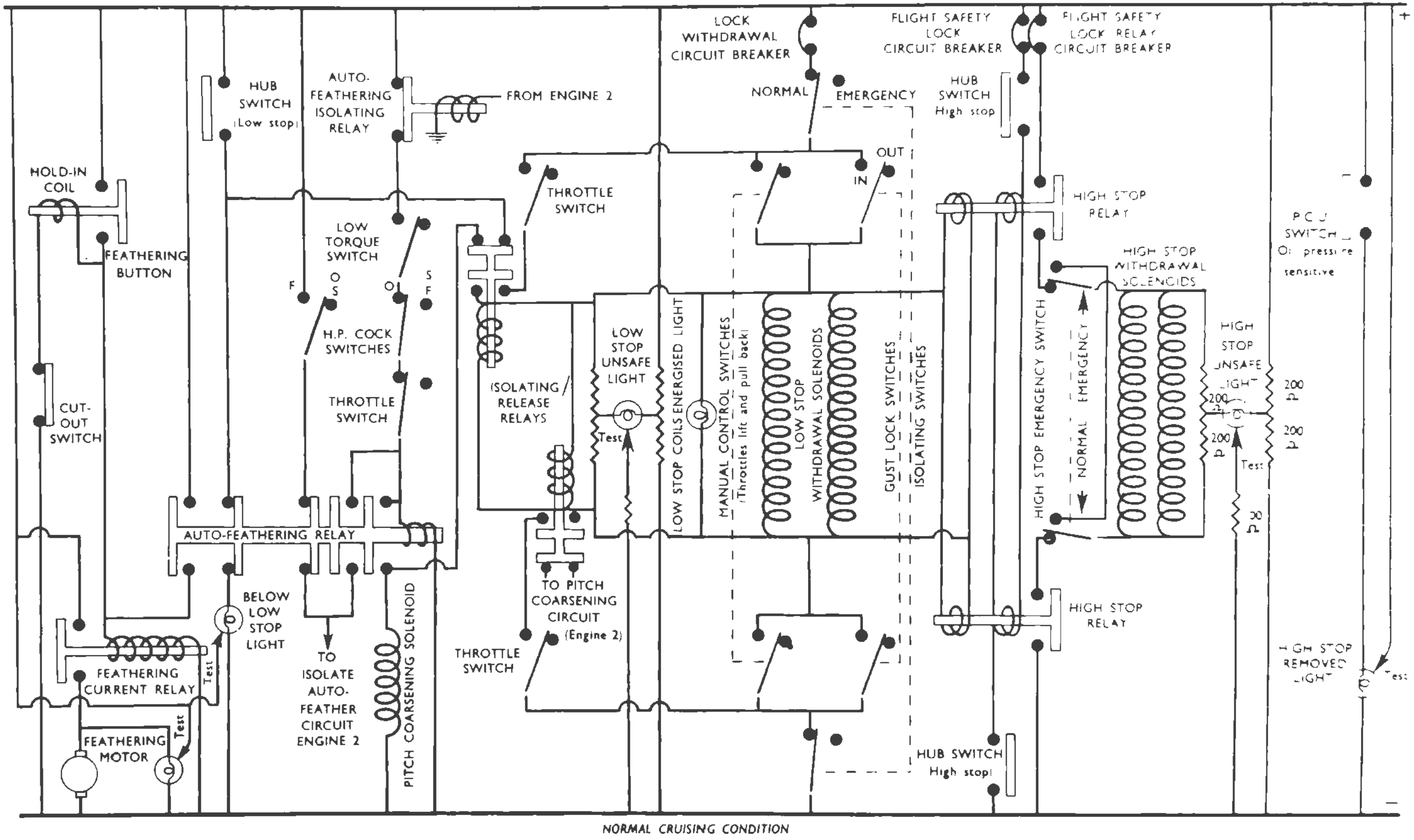
The propeller will therefore hunt over a small angular range round the low stop unless the blade angle is coarsened by an increase in aircraft forward speed or engine power.

Closing the hub switch also illuminates a 'propeller below low stop' indicating light, which will therefore alternate on and off while the pitch coarsening cycle is in operation. Provision is made for testing the lamp itself.

On the ground, the pitch coarsening circuit is normally rendered inoperative by the isolating/release relay, actuated when the low stop solenoids are energized.

High stop

The high stop is removed by an increase in pressure above the normal maximum in the fine pitch oil line to the propeller. This build-up in pressure



NORMAL CRUISING CONDITION

Fig. 3 **Typical Fokker Friendship two-stop propeller control system — electrical**

is achieved by hydraulically closing the relief valve in the fine pitch oil line, the pressure oil for this purpose being controlled in turn by a high stop withdrawal (increase pressure) solenoid.

The high stop withdrawal solenoids for both propellers are in series with the contacts of two relays; the coils of the relays themselves being energized through additional blade angle hub switches, set to close at 2 degrees above the high stop position and to remain closed at all finer pitch angles. Both propellers must therefore fine off together to complete the withdrawal circuit and remove the high stops. A single propeller fining off through some defect would be checked at its high stop until the other propeller had fined off sufficiently through normal reduction of power and engine speed to close the high stop withdrawal circuit.

These hub switches also close as the fully feathered position is approached on each propeller; this arrangement enables the withdrawal circuit to be completed for one propeller if the other is feathered.

In some aircraft, additional relays close to energize the high stop solenoids whenever the low stops are withdrawn.

A 'high stop unsafe' light, either wired in continuous circuit or used in conjunction with a test switch, is provided to give a warning should a short circuit occur such that one side of the circuit becomes 'live' with the high stops engaged. Provision is made for testing the lamps themselves (fig. 2 or 3).

Use is made of the lubrication bleed into the third oil line of the propeller shaft to operate a further high stop light switch which is oil pressure sensitive. The bleed is routed through the fine pitch relief valve, as shown in fig. 1.

This pressure sensitive switch is closed to illuminate a 'high stop removed' light by a rise in pressure in the bleed circulation. This normally occurs when the fine pitch relief valve is sealed off to withdraw the high stop. Alternatively, inadvertent withdrawal of the high stop through some defect would seal off the third oil line drain outlet and so produce the pressure build-up required to operate the light. The 'high stop removed' lamp itself may be proved.

A relief valve is included in the bleed system to limit the oil pressure in the third oil line and so prevent the low stop being withdrawn prematurely.

It should be noted that the light cannot remain on without engine pressure oil, i.e. when the engine is stationary.

During ground running, the propeller blades will not coarsen sufficiently to reach the high stop blade angle, even at maximum power conditions. The 'high stop removed' light will therefore remain on during all ground running.

When the aircraft exceeds a certain forward speed, however, as given in the aircraft manual, the 'high stop removed' lights should go out to indicate that the high stop withdrawal circuit is no longer energized and that the stops are in fact engaged.

Should the 'high stop removed' light or the 'high stop unsafe' light come on, it indicates that the stop withdrawal circuit is still armed wholly or in part; an emergency switch is therefore provided to isolate the stop withdrawal circuit in such circumstances (fig. 2 or 3).

The 'high stop removed' light may also indicate a mechanical defect of the lock system, in which case operation of the high stop emergency switch will neither extinguish the light nor rectify the defect. In these circumstances, a propeller failure resulting in the blade angle being suddenly reduced to the low stop angle could have serious consequences. The danger would be minimized by a reduction in aircraft forward speed to a low enough value to ensure the propeller blades are below the high stop angle.

To provide against the possible failure of the normal electrical withdrawal of a high stop, each propeller is equipped with a manual override control operated by the H.P. cock lever.

Selecting HIGH STOP WITHDRAWAL on the H.P. cock lever operates the isolating valve in the propeller controller unit (fig. 1). This valve then diverts high pressure oil directly into the fine pitch relief valve to close it and so cause the stop to be withdrawn.

NORMAL OPERATION

The r.p.m. control lever on the propeller controller unit and the throttle valve lever on the flow control unit are interconnected so that both are advanced when the pilot's throttle lever in the cockpit is opened.

During the initial opening of the pilot's throttle lever from the closed (Idling) position on the ground, fuel flow increases progressively with the opening of the throttle valve but the propeller remains on its ground fine pitch stop whilst the 'dead movement' in the controller unit mechanism is being taken up. This progressive increase in fuel flow causes the engine power to increase and therefore the r.p.m. to rise, with the propeller on its ground fine pitch stop, until the minimum constant speeding r.p.m. is reached.

Continued opening of the pilot's lever further increases fuel flow but without yet raising the r.p.m. setting at which the governor is controlling. This remains at the minimum constant speeding r.p.m. until the time when all the 'dead movement' is taken up and further advance of the pilot's throttle selects a higher engine speed. During this time, the propeller blades coarsen to absorb the rising engine power whilst the r.p.m. is maintained at the minimum controlled speed.

Subsequent advance of the pilot's lever now selects progressively higher r.p.m. in the cruising range as well as increasing the throttle valve opening. This process continues until maximum power conditions are reached at Take-off r.p.m.

When the throttle is opened whilst ground running an engine, the propeller 'below low stop' light does not go out until the throttle is advanced well into the cruising r.p.m. band.

Unless the flying controls gust lock lever is IN for ground running, the low stops will automatically engage and the 'low stop coils energized' light will go out if either or both throttles are advanced beyond 14,000 r.p.m. A warning horn (not shown in fig. 2 or 3) will sound at the same time as a reminder that it is necessary to engage the gust locks to withdraw the low stops before throttling back.

If either engine is idling or running with the propeller below the low stop angle, the other engine must not be opened beyond 14,000 r.p.m., unless the gust lock lever is at the IN position. The horn will also sound should this condition occur. The danger is that of overheating the idling engine, because pitch coarsening will take place when the low stop withdrawal circuit is broken by the throttle switch (fig. 2 or 3).

During take-off, the low stops are free to engage as soon as the blades have coarsened sufficiently, and the 'below low stop' lights will then go out. (The low stop withdrawal circuit will not be re-made until both throttles are lifted, pulled back and released.)

In flight, as during take-off, the low stop will always be engaged. In addition, when the aircraft forward speed has increased enough to require a sufficiently coarse blade angle, the high stop withdrawal circuit will be broken and the stops engaged (high stop removed lights out), so preventing a malfunctioning propeller from fining off excessively.

On reducing power, aircraft forward speed will fall and the propellers will fine off towards the high stop blade angle. When the propellers have reached a position 2 degrees above the high stop angle, the high stop withdrawal circuit will be completed through the hub switches, the stops will be withdrawn, and the 'high stop removed' lights will be illuminated.

Whilst the aircraft forward speed is being reduced, the propeller controller unit always maintains the engine speed selected by the pilot's throttle over the whole operating range of r.p.m. down to the minimum constant speeding r.p.m.

At the final stage of the approach, when the engines are throttled back fully for touch-down, the propellers will be windmilling on their low pitch stops, in their endeavour to maintain the minimum constant speeding r.p.m. Engine r.p.m. will therefore fall as aircraft forward speed diminishes.

After touch-down, the throttles are operated to energize the low pitch stop withdrawal circuit. Withdrawal of the stops permits the blades on both propellers to move into ground fine pitch as they still endeavour to maintain the minimum controlled r.p.m. The greatly increased drag assists in the retardation of the aircraft, whilst the r.p.m. rises momentarily on withdrawal of the stops, then falls progressively and drops to static ground idling as the aircraft is brought to rest. The 'low stop coils energized' light will come on as soon as the throttles are lifted and pulled back, followed by the 'below low stop' lights which come on just after the propeller blades have passed the low stop angle. The warning horn will sound if ground fine pitch has not been selected by the time the aircraft forward speed has dropped to 55 knots approximately.

FEATHERING

Manual

To feather the propeller, the pilot's H.P. cock lever is pulled back through the CLOSED 'gate' to FEATHER and the feathering button pressed. Moving the H.P. cock to FEATHER operates an override cam in the P.C.U. which mechanically raises the piston valve to admit high pressure oil to the propeller operating piston, causing the propeller to coarsen towards the feathered position (fig. 1).

The lever on the propeller controller unit which raises the piston valve also moves an isolating valve (fig. 1). This movement ensures that while feathering is selected, no oil can be admitted to the solenoids controlling the withdrawal of the high and low pitch stops which might cause inadvertent withdrawal of these stops.

The feathering pump is started to replace or add to the supply of oil from the controller unit pump. This is effected through a relay when the feathering button is pressed; simultaneously, a 'feathering current warning' light is illuminated (fig. 2 or 3). Provision is made for this lamp to be tested.

When the propeller is fully feathered, an oil pressure operated cut-out switch releases the feathering button, thus cutting the supply of current to the pump motor.

Whenever FEATHER is selected on the H.P. cock lever of one engine, auto-feathering is prevented from occurring on the other by an isolating relay, which also cuts off the water/methanol supply to the feathered engine, and relieves the remaining engine of unnecessary auxiliary load.

Automatic

To assist the pilot in the event of engine failure during take-off or flight, an automatic feathering system is fitted to each engine, operated by a low torque switch in series with microswitches on the pilot's H.P. cock and throttle controls.

If, when the H.P. cock is open and the throttle is at cruising or above, the torque meter oil pressure from the engine falls below a certain value, the low torque switch completes the circuit to a pitch coarsening relay (fig. 2 or 3). This relay energizes the pitch coarsening solenoid in the propeller controller unit, causing the piston valve to be raised hydraulically and the propeller to feather. Energizing this relay operates simultaneously the switches starting the feathering pump and isolates the propeller 'below low stop' warning light.

With the engine stationary, the low torque switch will be closed. If the H.P. cock is then positioned at OPEN or at HIGH STOP WITHDRAWAL, opening the throttle into the cruising range will cause the propeller to auto-feather unless the H.P. cock on the other engine is moved to the FEATHER position.

If the auto-feathering system has been energized on one engine, a signal is fed into the auto-feathering isolating relay of the other engine, in a similar manner and with the same results as when the H.P. cock lever is moved to FEATHER.

When auto-feathering is complete, it is important that the manual feathering procedure is carried out or the feathering pump motor will continue to run, as the automatic cut-out switch for the motor is not brought into the circuit when auto-feathering.

UNFEATHERING

To unfeather the propeller on the ground, the pilot's H.P. cock lever must be moved from FEATHER to allow the propeller controller piston valve to assume its lowered position.

Pulling and holding out the feathering button to start the feathering pump will then cause high pressure oil to be delivered into the propeller fine pitch oil line, and the propeller will normally unfeather to the ground fine pitch stop.

There is a relief valve discharging from the fine pitch into the coarse pitch oil line (fig. 1), and an excessive amount of oil will be passed into the lubrication system and flood the engine unless this relief valve is locked on to its seat. For all ground unfeathering operations, therefore, it is essential to select HIGH STOP WITHDRAWAL (LOCK OUT) on the pilot's cockpit lever before starting the feathering pump.

During unfeathering the feathering current warning light will continue to glow until the feathering button is released.

MAINTENANCE PRACTICES

PROPELLER CONTROLLER UNIT

SERVICING

Secondary vibration of the engine caused by an internal defect, not necessarily apparent as rough running, may result in cracking of the control levers on the P.C.U. If such cracking is found in service, therefore, the engine must be removed for examination.

If any external seepage of oil is noted from the feathering pump cut-out switch in the P.C.U., the switch must be changed, and the connecting electrical leads examined for possible oil contamination, and rectified as required. Examine also the other connections in the same harness assembly; if oil has penetrated to any of these or if it is suspected that oil has reached the main conduit, change the harness assembly.

To remove the cut-out switch from the P.C.U., first disconnect the electrical connection of the switch. Remove the wirelocking and unscrew the four retaining setscrews, then withdraw the switch.

When fitting a new or replacement cut-out switch, renew the gasket seal.

REMOVAL

Disconnect the electrical leads from the following:

Pitch coarsening solenoid
Low pitch stop withdrawal solenoid
High pitch stop withdrawal solenoid
Feathering pump motor cut-out switch
High stop removed warning light switch.

Disconnect the feathering oil pipe at the controller.

Disconnect the r.p.m. control and feathering selector rods from the control levers.

Remove the six securing nuts and washers, and lift the unit off the engine, leaving the quill drive in the engine.

Remove the quill drive and visually examine the splines for wear and plucking. If excessive wear or plucking of the splines is evident, reject the quill drive. Wear of the splines in excess of 0.005 in. is not acceptable.

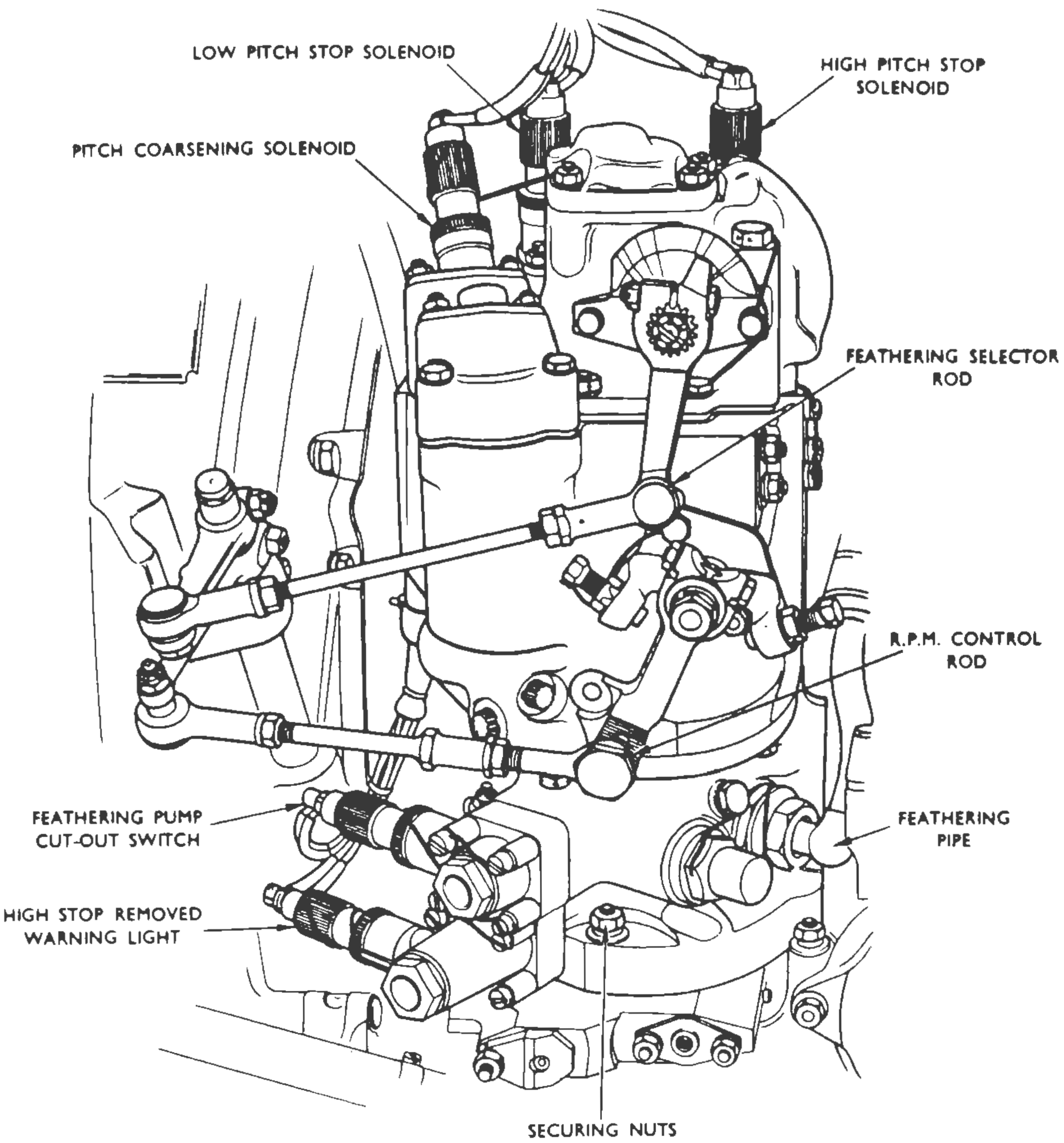


Fig. 201 P.C.U. connection points

REPLACEMENT

Renew the joint washer on the mounting face before replacing the unit.

Ensure that the quill drive is correctly engaged during replacement by rotating the engine before tightening the securing nuts.

Connect the feathering oil pipe and the five electrical leads.

Reconnect the r.p.m. and feathering selector rods to their levers, and adjust as described in 76-0, 'Maintenance practices', under 'Replacement unit settings'.

Note: It is important when fitting or replacing the P.C.U. to torque tighten the ¼ in. B.S.F. securing nuts to the standard loading given in 89-3, even though Grover washers are used; use universal spanner AK.647 where required.

Failure to observe this instruction can result in internal oil leakage, affecting the operation of the unit. Re-check the torque loading of the securing nuts at the first convenient aircraft inspection period within 100 to 200 hours of installation.

SERVICEABILITY CHECK

Carry out the propeller system checks and the recommended ground run, as described in 71-0 under 'Adjustment/test'.

Check for oil leaks when the engine has stopped.

MAINTENANCE PRACTICES

FEATHERING PUMP

Any rough running of the engine may result in the cracking of certain external components. If the feathering pump mounting flange is found to be cracked, therefore, refer to 71-0, 'Trouble shooting', under 'Rough running'.

REMOVAL

Disconnect the electrical connections and the oil outlet pipe from the pump.

Remove the two setscrews securing the pump suction pipe retaining sleeve to the drain valve housing on the lower left-hand side of the air intake casing.

Rotate the keep plate 60 degrees and withdraw it along the pipe away from the drain valve housing.

Withdraw the sealing tube from the drain valve housing into the bore of the suction pipe, thus allowing the sealing valve to close.

Remove the pipe retaining clip from the scavenge pump outlet connection.

Rotate the pipe to unlock the bayonet connection securing the pipe to the feathering pump, and withdraw the pipe; if necessary, disconnect the flexible oil return pipe at the oil cooler end to facilitate access.

The feathering pump can now be withdrawn from its mounting on the oil filter bowl by removing the four securing nuts.

REPLACEMENT

Ensure the pump is full of oil before securing it to the filter bowl with the four nuts.

Renew all rubber sealing rings, including those on the sealing tube, and smear with engine oil. Replace the sealing tube in the pipe.

Enter the suction pipe into the feathering pump and rotate to the locking position.

Extend the sealing tube from the bore of the pipe and mate it to the drain valve housing, thus opening the valve.

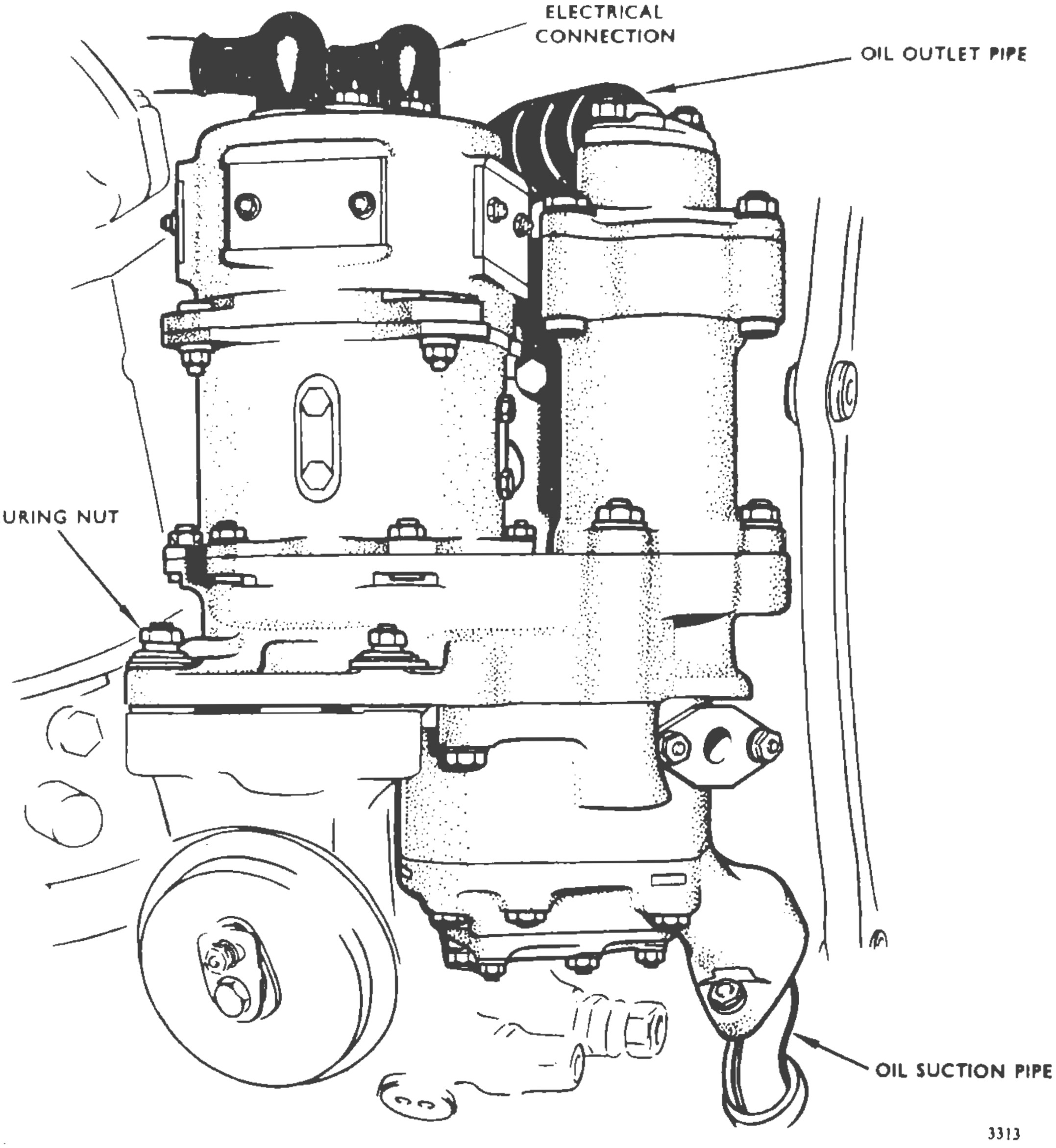
Slide the keep plate along the suction pipe, rotate it between the two 'rings' of lugs on the pipe to the locking position, and align the holes.

Secure the joints by passing the setscrews through the retaining sleeve and sealing tube into the drain valve housing and tightening them.

Secure the pipe clip to the scavenge pump outlet connection with the setscrew.

Reconnect the electrical connections and the oil outlet pipe.

Reconnect the flexible oil return pipe at the oil cooler end, if disconnected, using a new joint packing.



Feathering pump connection points
Fig.201

SERVICEABILITY CHECK

Carry out a static feathering check as follows, observing the three-minute limitation on the use of the feathering pump motor.

Note Motoring or ground running to return displaced oil to the tank and the possible oil flooding of the engine can both be avoided by fitting the special oil by-pass equipment (see 'Engine, Adjustment/test, Propeller system functional checks').

Select FEATHER on the pilot's H.P. cock lever and press the feathering button, the propeller should feather normally.

Selecting lock out (H.P. cock lever fully forward, not at OPEN), unfeather the propeller and ensure feathering pump off.

If the special oil by-pass equipment has not been fitted, observe the usual oil level precautions and ground run the engine for 10 minutes at 11,000 r.p.m. to return displaced oil to the tank.

Repeat the feathering and unfeathering operation if necessary to eliminate possible air locks and obtain normal operation; follow by further ground running as above if the by-pass equipment has not been fitted.

Inspect the feathering pump connections for signs of leakage.

CHAPTER 71 - POWER PLANT

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POWER PLANT - TROUBLE SHOOTING

1. General

A. The procedure given in the following pages assumes that the relevant parameters have been corrected for ambient conditions where necessary and that the correct handling drill has been followed.

B. Where defects are indicated by aircraft instruments, the instruments should first be checked for accuracy. The fault finding procedure set out in this section incorporates this principle and it is recommended that the investigations sequence should be as tabulated.

2. Flight performance faults

A. T.G.T., torque, fuel flow and fuel datum

(1) As it is not practicable to establish standards of comparison for T.G.T., torque pressure, fuel flow and fuel datum positions for only 2 engines, recognition of a defect requires experience of what is 'normal' for the particular engines under similar flight conditions.

(2) Flight performance defects can be indicated by excessive variation between associated engine gauges (T.G.T., torque pressure, fuel flow and fuel datum position) on a particular engine or, by the departure in a complete set of readings on one engine from the normally accepted parameters. Typical symptoms are listed in this paragraph quoting combinations of unusual or unrelated engine readings.

(3) When engines are trimmed to the cruising T.G.T., a difference between the fuel datum indicator readings can exist and may be as much as 40 per cent. This is acceptable providing it is not accompanied by abnormal discrepancies in the associated engine parameters.

(4) When reading a torque meter pressure gauge, distinction must be made between a regular fluctuation of up to 10 p.s.i. on either side of a mean value, which is acceptable, provided it is not accompanied by corresponding fluctuations on other engine gauges, and a gauge reading which flickers constantly downwards is frequently a sign of a defective transmitter system; the latter may be confirmed by moving the throttle to a new position when the flicker should be temporarily eliminated. Torque pressure should be regarded as a main symptom of an engine defect only if there is a severe drop in the observed value.

(5) Rectification of flight performance defects requires proving in flight as well as by ground run.

Power plant - Trouble shooting (cont.)

B. Torquemeter calibration change (torque shift)

(1) If, after carrying out the relevant checks specified in this section, it is suspected that a torquemeter calibration change of not more than 30 p.s.i. from the acceptance limit has occurred, it is possible to redeclare the torquemeter calibration (on the wing) provided that, the engine running time is not more than 50 hours from test bed run for DOWNWARD torque shift, or 500 hours from test bed run for UPWARD torque shift and the following procedure is effected:

(a) Calibrate the engine instrumentation.

(b) Fit a master torque pressure gauge and a Foster potentiometer for the ground run; refer to Sub-section 4A 'INSTALLATION GROUND RUN - DRY'.

(c) Start the engine; refer to 3. 'STARTING, MOTORING AND STOPPING DRILL'.

(d) Set the fuel datum (corrected for humidity) for the prevailing ambient conditions; refer to Sub-section 4.E. 'CHARTS'.

(e) Open the throttle fully at the lowest oil temperature possible, (observing the minimum opening-up oil temperature of -15 degrees C.) but NOT above 70 degrees C.

(f) At the correct take-off r.p.m., record the following at 10 degrees increments of oil inlet temperature up to the maximum obtainable within the 5 min. take-off r.p.m. limitation, but not exceeding 120 degrees oil inlet temperature:

Oil inlet temperature

Torque pressure

Turbine gas temperature

Fuel flow

Time, in minutes and seconds, since selecting full throttle.

NOTE: The above information is necessary to determine torquemeter sensitivity to oil temperature.

CAUTION: ONLY ROLLS-ROYCE (1971) LIMITED MAY EFFECT THE CALCULATIONS NECESSARY TO REDECLARE THE TORQUEMETER CALIBRATION (ON THE WING).

(g) Submit the information recorded in (f) and other information listed in Fig.101 to:

Customer Support Manager - Dart
Rolls-Royce (1971) Limited
Nerston Industrial Estate
EAST KILBRIDE
Glasgow G74 4PY

Power plant - Trouble shooting (cont.)

Engine No.......... Mk. No. .... Hours since last test bed run.........

TEST CERTIFICATE DATA

Max. T.G.T........°C. Min. T.G.T.......°C. Fuel flow............

E.P.C.P. at 70°C. O.I.T........ E.P.C.P. at 100°C. O.I.T...........

W.M.C.P...........

INSTALLATION GROUND RUN DATA (Not required for torque shift on initial installation)

Pressure Altitude......... O.A.T...........) (Mintorque values at
Wet bulb Temp............. Dry bulb Temp.....) (70 and 100°C.
) OR and
Fuel trim position........ R.P.M.............) (Torque pressure upper
(limit at 70 and 100°C
O.I.T..... T.P...... T.G.T..... Fuel flow.....) (and DATA-PLATE W.M.C.P.

OIL TEMP. SENSITIVITY GROUND RUN DATA

Pressure altitude .... O.A.T...................
Wet bulb Temp.............. Dry bulb Temp...........
Fuel trim position......... R.P.M. ....

O.I.T.	Torque pressure	T.G.T.	Fuel flow	Time at full throttle but not exceeding 5 min.
* 50				
60				
70				
80				
90				
100				
110				
120				

* It will not always be possible to cover the full O.I.T. range; readings should be taken over the maximum range available, without exceeding the O.I.T. limitation.

Typical chart for torquemeter calibration change 'on the wing' redeclaration
Fig.101

Flight performance faults

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
T.G.T. normal torque high, fuel flow high, fuel datum high (too near full increase) or T.G.T. low, torque normal, fuel flow normal, with fuel datum at full increase	Pyrometry reading low	Fit Foster potentiometer Ground run Check pyrometry	Sub-section 4A - 'INSTALLATION GROUND RUN - DRY' Sub-section 4C - 'IN-SERVICE GROUND RUN - DRY' Chapter 77-2-1 'THERMOCOUPLES AND HARNESS - MAINTENANCE PRACTICES' - 2 Adjustment/test
T.G.T. normal, torque normal, fuel flow normal, fuel datum high or T.G.T. low, torque low, fuel flow low, with fuel datum at full increase	R.p.m./fuel flow control interconnection incorrect (low fuel flow)	Check control static settings; ensure synchro system on datum Ground run	Chapter 76-0 - 'ENGINE CONTROLS MAINTENANCE PRACTICES'. Sub-section 4C - 'IN-SERVICE GROUND RUN - DRY'. If defect persists, renew in turn: Fuel control unit - Chapter 73-3 'FUEL CONTROL UNIT - MAINTENANCE PRACTICES'. Propeller controller unit - Chapter 61-1, 'CONTROLLER UNIT - MAINTENANCE PRACTICES' Propeller - Chapter G2 (61-10-0), Aircraft Maintenance Manual - 'PROPELLER INSTALLATION'

Flight performance faults (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
T.G.T. normal, torque low, fuel flow low, fuel datum low (too near full decrease) or T.G.T. high, torque normal or low, fuel flow normal or low, with fuel datum at full increase	Pyrometry reading high or Engine deterioration	Fit Foster potentiometer	Sub-section 4A - 'INSTALLATION GROUND RUN - DRY'
		Ground run	Sub-section 4C - 'IN-SERVICE GROUND RUN - DRY'
		Check pyrometry	Chapter 77-2-1, 'THERMOCOUPLES AND HARNESS - MAINTENANCE PRACTICES' - 2. Adjustment/test
T.G.T. normal, torque normal, fuel flow normal, fuel datum low or T.G.T. high, torque high, fuel flow high, with fuel datum at full increase	R.p.m./fuel flow control interconnection incorrect (high fuel flow)	Check control static settings; ensure synchro system on datum	Chapter 76-0, 'ENGINE CONTROLS MAINTENANCE PRACTICES'
		Ground run	Sub-section 4C 'IN-SERVICE GROUND RUN - DRY'. If defect persists, renew in turn: Fuel control unit, Chapter 73-3, 'FUEL CONTROL UNIT - MAINTENANCE PRACTICES'. Propeller controller unit, Chapter 61-1, 'CONTROLLER UNIT - MAINTENANCE PRACTICES'. Propeller - Chapter G2 (61-10-0) Aircraft Maintenance Manual - 'PROPELLER INSTALLATION'.

Flight performance faults (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
T.G.T. high, fuel flow high with fuel datum at full decrease in cruise/climb	Insufficient fuel trimmer range because of high ambient temperature and/or engine performance deterioration	Check control static settings; ensure synchro system on datum	Chapter 76-0, 'ENGINE CONTROLS - MAINTENANCE PRACTICES'.
		Ground run	Sub-section 4C 'IN-SERVICE GROUND RUN - DRY'
		Clean compressor	Chapter 72-3, 'COMPRESSOR - MAINTENANCE PRACTICES'

Flight performance faults (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Change in T.G.T./fuel flow relationship at altitude, necessitating change in fuel trim	Failure of fuel burner shroud nut(s)	NOTE: Fuel burners to Mod.1625, 1626 or S.B.Da73-68 standard need not be inspected. Remove and dismantle combustion chambers as instructed in Chapter 72-5, 'COMBUSTION SECTION - MAINTENANCE PRACTICES' sufficiently to inspect burner shrouds for cracks. If there is no evidence of cracks and symbols 'H' and 'C' are engraved on any adjacent serrations, accept burner as serviceable; record compliance of SB.Da73-68 in engine log book. If symbols 'H' and 'C' are not observed or 'H' only is observed, refer to S.B.Da73-68.	
		If shroud nuts are cracked	Inspect turbine for evidence of overheating, Chapter 72-6, 'TURBINE AND NOZZLE BOX - MAINTENANCE PRACTICES'; reject engine if inspection is unsatisfactory. If inspection is satisfactory, fit replacement burner to Mod.1625, 1626 or S.B.Da73-68 standard.

Flight performance faults (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Fluctuation of r.p.m., torque pressure and fuel flow			
- with fuel pressure warning light on	Aircraft fuel supply	Check aircraft fuel system	Bleed complete fuel system, Chapter 73-0, 'ENGINE FUEL AND CONTROL - MAINTENANCE PRACTICES' and Fuel and Water Methanol System - Chapter H3 (28-00), Aircraft Maintenance Manual - 'SERVICING AND MAINTENANCE'
- with fuel filter icing warning light on. If the reported symptoms have continued for more than 5 minutes, fuel pump cavitation may have occurred; refer to Chapter 73-2 , 'FUEL PUMP - MAINTENANCE PRACTICES'	Contamination or icing of fuel filter. Defect in pressure differential switch		Refer to Chapter 73-3, 'FUEL CONTROL UNIT - MAINTENANCE PRACTICES' and Fuel and Water Methanol System - Chapter H3 (28-00), Aircraft Maintenance Manual 'SERVICING AND MAINTENANCE'
Sudden increase in torque pressure with T.G.T. normal, fuel flow normal and fuel datum normal	Reduction gear defect	Examine oil filters	Chapter 72-8, 'OIL SYSTEM - MAINTENANCE PRACTICES' Reject engine if examination of oil filters confirms reduction gear defect. If filters are acceptable carry out ground run, Sub-section 4C 'IN-SERVICE GROUND RUN - DRY'.

Flight performance faults (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Sudden increase in torque pressure with T.G.T. normal, fuel flow normal and fuel datum normal (cont.)			Check torque pressure, using Bourdon tube type gauge. If torque pressure is satisfactory renew transmitter and/or indicator. If high torque pressure is confirmed, refer to 2.B. 'Torquemeter calibration change'

Engine starting faults

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Starter and engine do not turn	Electrical supply or starter motor defective	Check for adequate electrical supply voltage on aircraft voltmeter	If electrical supply satisfactory, change starter motor, Chapter 80-1, 'STARTER MOTOR - MAINTENANCE PRACTICES'.
Starter turns, engine does not rotate	Internal engine defect	Check propeller for rotation in both directions	Reject engine if unusual noise occurs, Chapter 72-0, 'POWER PLANT - INSPECTION/ CHECK'.
	Starter drive assembly defective	Suspect defective clutch	Change drive assembly, Chapter 80-1, 'STARTER MOTOR - MAINTENANCE PRACTICES'.
Starter turns, engine turns but fails to start	Igniter system defective	Check igniter system	Rectify igniter system as required, Chapter 80-2, 'IGNITER PLUGS AND LEADS - MAINTENANCE PRACTICES'.
	Sheared H.P. fuel pump quill-drive shaft or F.C.U. defective	Disconnect servo pressure pipe at H.P. fuel pump; fit pressure blanks to pipe end and connection on pump. Ensure propeller at ground fine pitch and trip appropriate circuit breakers to isolate pitch coarsening circuit. Effect a motoring cycle with H.P. cock and throttle lever open. Check for fuel discharge at the drain valve overboard outlet.	Sub-section 3. 'STARTING, MOTORING AND STOPPING DRILLS'. If no fuel discharged, change H.P. fuel pump, Chapter 73-2, 'FUEL PUMP - MAINTENANCE PRACTICES'. If fuel discharged or pump delivery pressure below 150 p.s.i., change F.C.U., Chapter 73-3, 'FUEL CONTROL UNIT - MAINTENANCE PRACTICES'.

Engine starting faults (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Starter turns, engine turns but fails to start (cont.)	Engine controls incorrectly set (insufficient idling gap)	Check fuel pump delivery pressure	
		Check control static settings, ensure synchro system on datum	Chapter 76-0, 'ENGINE CONTROLS - MAINTENANCE PRACTICES'.
		Ground run	Sub-section 4C 'IN-SERVICE GROUND RUN - DRY'.
Engine fails to light-up. Change in engine starting characteristics. Higher than normal indicated idling fuel flow with no increase in idling r.p.m.	Failure of fuel burner shroud nut(s)	NOTE: Fuel burners to Mod.1625, 1626 or S.B.Da73-68 standard need not be inspected. Remove and dismantle combustion chambers, as instructed in Chapter 72-5 'COMBUSTION SECTION - MAINTENANCE PRACTICES' sufficiently to inspect burner shrouds for cracks. If there is no evidence of cracks and symbols 'H' and 'C' are engraved on any adjacent serrations, accept burner as serviceable; record compliance of S.B.Da73-68 in engine log book. If symbols 'H' and 'C' are not observed or 'H' only is observed, refer to S.B.Da73-68.	

Engine starting faults (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Engine fails to light-up. Change in engine starting characteristics. Higher than normal indicated idling fuel flow with no increase in idling r.p.m. (cont.)		If any shroud nuts are cracked	)Inspect turbine for evidence)of overheating as instructed)in Chapter 72-6, 'TURBINE AND)NOZZLE BOX - MAINTENANCE)PRACTICES'; reject engine if)inspection is unsatisfactory.)If inspection is satisfactory,)fit replacement burner to)Mod.1625, 1626 or S.B.Da73-68)standard.
High T.G.T. on starting or H.P. cock metering required.	Propeller not at ground fine pitch	Check, marks on spinner and blades aligned	With H.P. cock SHUT operate feathering/unfeathering switch to obtain alignment; release switch when marks on spinner and blades are aligned.
	Low motoring speed (less than 1800 r.p.m.) due to:		
	1. Faulty electrical supply	Check electrical supply i.e. Aircraft batteries for internal start, or ground power unit for external starts	Ensure minimum requirements for starting equipment are met, Chapter 89-11, 'SPECIFICATION FOR ENGINE STARTING EQUIPMENT'
	2. Defective starter clutch	Remove starter motor. Remove starter drive assembly.	Chapter 80-1, 'STARTER MOTOR - MAINTENANCE PRACTICES'.
		Examine starter clutch casing for signs of overheating and for metal particles.	
		Examine the pressure oil filter for foreign matter.	Chapter 72-8, 'OIL SYSTEM - MAINTENANCE PRACTICES'.

Engine starting faults (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
High T.G.T. on starting or H.P. cock metering required (cont.)	3. Defective starter motor		If electrical supply satisfactory, change starter motor
	4. Excessive idling fuel flow	Check control static settings ensuring synchro system on datum	Re-adjust as required, Chapter 76-0, 'ENGINE CONTROLS IN POWER PLANT - MAINTENANCE PRACTICES'
		If defect persists, effect a burner pressure check, Chapter 73-0, 'ENGINE FUEL AND CONTROL - MAINTENANCE PRACTICES'	If outside limits, change F.C.U., Chapter 73-3, 'FUEL CONTROL UNIT - MAINTENANCE PRACTICES'
Engine fails to reach idling speed or needs throttle manipulation	Incomplete light up or insufficient idling fuel flow	Ensure throttle lever fully closed, then open sharply 1 in. approx. to ensure complete light up. Close throttle	
		If idling speed is now within limitations suspect burners	Clean burners, Chapter 73-1, 'FUEL BURNERS - MAINTENANCE PRACTICES'
		If idling speed is below 6,500 r.p.m. suspect idling fuel flow and check:	
		Control static settings ensuring synchro system on datum	Chapter 76-0, 'ENGINE CONTROLS IN POWER PLANT - MAINTENANCE PRACTICES'
		If control static settings satisfactory check burner pressure	Chapter 73-0, 'ENGINE FUEL AND CONTROL - MAINTENANCE PRACTICES'

Engine starting faults (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Engine fails to reach idling speed or needs throttle manipulation (cont.)			If outside limits, change F.C.U., Chapter 73-3, 'FUEL CONTROL UNIT - MAINTENANCE PRACTICES'

R.P.M. faults

Maximum r.p.m. should be checked or set at an oil inlet temperature of 65 to 75 degrees C.

Where the accuracy of one engine r.p.m. indicator is known, it can be used with the synchro system to check the other r.p.m. gauge.

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Max. r.p.m. incorrect (with oil temp. 65 to 75 deg.C.)	R.p.m. indicator system defective	Using a master gauge,calibrate r.p.m. indicator system	Fit calibrated gauge and/or serviceable tachometer generator
	Interference by control stops	Check control static settings, ensure synchro system on datum	Chapter 76-0, 'ENGINE CONTROLS - MAINTENANCE PRACTICES'
	If r.p.m. error excessive suspect P.C.U. or propeller		Change propeller controller unit, Chapter 61-1, 'CONTROLLER UNIT - MAINTENANCE PRACTICES'and/or Propeller - Chapter G2, (61-10-0) Aircraft Maintenance Manual - 'PROPELLER INSTALLATION'
Min. constant speeding r.p.m. incorrect	P.C.U.incorrectly set	Ground run	Sub-section 4C 'IN-SERVICE GROUND RUN - DRY' Change propeller controller unit, Chapter 61-1, 'CONTROLLER UNIT - MAINTENANCE PRACTICES'
Idling r.p.m. incorrect	1. Incorrect adjustment of controls	Check control static settings; ensure synchro system on datum	Chapter 76-0, 'ENGINE CONTROLS IN POWER PLANT - MAINTENANCE PRACTICES'
	2. If controls satisfactory, suspect idling fuel flow	Carry out burner pressure check	Chapter 73-0, 'ENGINE FUEL AND CONTROL - MAINTENANCE PRACTICES'

R.P.M. faults (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Idling r.p.m. incorrect (cont.)			If outside limits, change F.C.U., Chapter 73-3, 'FUEL CONTROL UNIT - MAINTENANCE PRACTICES'.
	3. If r.p.m. low, suspect incomplete light up	With throttle fully closed, open sharply 1 inch approx. to ensure complete light up, then close as far as possible without reducing r.p.m. below 6,500 r.p.m.	
		If throttle then fully closed, suspect burners	Clean fuel burners, Chapter 73-1, 'FUEL BURNERS - MAINTENANCE PRACTICES'.
		If throttle not then fully closed, suspect idling fuel flow	Effect checks 1 and 2
Fluctuating r.p.m.	P.C.U. mounting face joint washer settling	Check P.C.U. securing nuts for correct torque loading	Chapter 89-3, 'TORQUE TIGHTENING TECHNIQUE'
Fluctuating r.p.m. with falling T.G.T. and torque	Aircraft fuel supply	Check aircraft fuel system	Bleed complete fuel system, Chapter 73-0, 'ENGINE FUEL AND CONTROL - MAINTENANCE PRACTICES'.
	Air in fuel system		

R.P.M. faults (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Fluctuating r.p.m. with falling T.G.T. and torque (cont.)	Fuel filter de-icing system defective	Check electrical system. Check hot-air valve operation	If electrical supply to unit satisfactory, change hot-air valve, Chapter 75-1-1, 'HOT-AIR VALVE - MAINTENANCE PRACTICES'. If valve sticking open, change unit and bleed fuel system.
	Fuel contamination	Take fuel sample and test	Rectify source of contamination. Renew filter element, Chapter 73-3, 'FUEL CONTROL UNIT - MAINTENANCE PRACTICES' Bleed fuel system
	Engine partial flame-out due to ice ingestion	Check operation of power unit ice protection system	Sub-section 4C 'IN SERVICE GROUND RUN - DRY' and Aircraft Maintenance Manual Chapters M3, 'ANTI-ATMOSPHERICS - SERVICING AND MAINTENANCE' or 30-60-0, 'POWER UNIT DE-ICING - MAINTENANCE PRACTICES'
Fluctuating r.p.m. with similar conditions showing on torque and T.G.T. parameters	Flame tube swirler detached, disturbing combustion pattern	Remove combustion assemblies for inspection	

5. T.G.T. faults

Before investigating any reported T.G.T. faults at maximum conditions, ensure that the maximum r.p.m. is accurately set. It is important also to verify that the trimmer setting procedure has been correctly carried out in accordance with prevailing O.A.T. and pressure altitude readings.

Torque pressure is described as 'satisfactory' when it lies within the applicable torque pressure acceptance limits, specified in the relevant Sub-section of Section 4.

The T.G.T. is not directly related to power when water/methanol is being used but, the appropriate take-off T.G.T., with water/methanol, must not be exceeded; refer to: Section 1 'ENGINE HANDLING'.

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
T.G.T. low at 15,000 r.p.m.			
- with satisfactory torque	Pyrometry reading low	Check pyrometry	Chapter 77-2-1, 'THERMOCOUPLES AND HARNESS - MAINTENANCE PRACTICES'
- with low torque	Insufficient fuel flow due to: fuel pump governor or stall pressure interference	Slowly close throttle from fully open and watch for rise in T.G.T.	If T.G.T. rises, check governor and reset if required. If governor found satisfactory, change fuel pump, Chapter 73-2, 'FUEL PUMP - MAINTENANCE PRACTICES'
	engine control settings incorrect	Check static settings, ensuring synchro system on datum	Chapter 76-0, 'ENGINE CONTROLS - MAINTENANCE PRACTICES'
	aircraft fuel supply	Investigate possible flow restriction	Ground run, Sub-section 4C 'IN-SERVICE GROUND RUN - DRY'

T.G.T. faults (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
T.G.T. low at 15,000 r.p.m. - with low torque (cont.)	Incomplete light up (low T.G.T. and torque apparent at all engine speeds)	Close throttle fully, open sharply 1 inch approx. to ensure complete light up, then close as far as possible, without reducing r.p.m. below 6,500 r.p.m.	
		If throttle then fully closed, suspect burners	Clean burners, Chapter 73-1, 'FUEL BURNERS - MAINTENANCE PRACTICES'
		If throttle not then fully closed, suspect idling fuel flow and check control static settings, ensuring synchro system on datum. If satisfactory, check burner pressure	If outside limits, change F.C.U., Chapter 73-3, 'FUEL CONTROL UNIT - MAINTENANCE PRACTICES'

T.G.T. faults (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
T.G.T. low at 15,000 r.p.m. - with low torque (cont.)	Fuel filter de-icing system defective (low T.G.T. and torque apparent at all engine speeds)	Check system	Aircraft Maintenance Manual, Chapter H3, 'SERVICING AND MAINTENANCE FUNCTIONAL TESTS - FUEL HEATER CONTROL AND WARNING' or 28-20-0, 'FUEL DISTRIBUTION - MAINTENANCE PRACTICES'. If, the electrical system is satisfactory, change hot air valve, Chapter 75-1-1, 'HOT AIR VALVE - MAINTENANCE PRACTICES'. Bleed fuel system, Chapter 73-0, 'ENGINE FUEL AND CONTROL' and Chapter H3 (28-00), Aircraft Maintenance Manual 'FUEL AND WATER/METHANOL SYSTEM - SERVICING AND MAINTENANCE'

T.G.T. faults (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
T.G.T. high at 15,000 r.p.m. - with satisfactory or low torque	Pyrometry reading high	Check pyrometry	Chapter 77-2-1, 'THERMOCOUPLES AND HARNESS - MAINTENANCE PRACTICES'
	Engine deterioration	Carry out engine power check	Sub-section 4C 'IN-SERVICE GROUND RUN - DRY'
	Excessive engine air offtakes/ Defective power unit ice protection system	(a) Check fuel heating system for correct functioning	(a) Relevant ground run in Section 4.
		(b) Isolate aircraft wing de-icing system by blanking air offtake connection on engine compressor outlet	(b) If T.G.T. Torque pressure is satisfactory, refer to Aircraft Maintenance Manual Chapters M3, 'ANTI-ATMOSPHERICS' or 30-10-0 'AIRFOIL PNEUMATIC DE-ICING - MAINTENANCE PRACTICES'
		(c) Check functioning of power unit ice protection system	(c) Relevant ground run in Section 4.
- with high torque	Excessive fuel flow because engine control settings incorrect	Check static settings; ensure synchro system on datum	Chapter 76-0, 'ENGINE CONTROLS - MAINTENANCE PRACTICES' Ground run, Sub-section 4C 'IN-SERVICE GROUND RUN - DRY'
Fluctuating T.G.T. with similar conditions showing on r.p.m. and torque parameters	Flame tube swirler detached disturbing combustion pattern	Remove combustion assemblies for inspection	Replace flame tubes as necessary, Chapter 72-5, 'COMBUSTION SECTION - MAINTENANCE PRACTICES'

T.G.T. faults (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
T.G.T. is unusually sensitive to small movements of throttle	Failure of fuel burner shroud nut(s)	NOTE: Fuel burners to Mod.1625, Mod.1626 or S.B.Da73-68 standard need not be inspected. Remove and dismantle combustion chambers, as instructed in Chapter 72-5, 'COMBUSTION SECTION - MAINTENANCE PRACTICES', sufficiently to inspect burner shrouds for cracks. If there is no evidence of cracks and symbols 'H' and 'C' are engraved on any adjacent serrations, accept burner as serviceable; record compliance of S.B.Da73-68 in engine log book. If symbols 'H' and 'C' are not observed or 'H' only is observed; refer to S.B.Da73-68.	
		If any shroud nuts are cracked	)Inspect turbine for evidence)of overheating, Chapter 72-6.)'TURBINE AND NOZZLE BOX -)MAINTENANCE PRACTICES';)reject engine if inspection is)unsatisfactory.)If inspection is satisfactory)fit replacement burner to Mod.)1625, Mod.1626 or S.B.Da73-68)standard.

Torque pressure faults

A. The recommended method of checking the torque pressure transmitter system is by fitting a T-piece adapter between the transmitter oil pipe and its connection on the W.M.C.U., connecting an accurately calibrated Bourdon tube type gauge, and then carry out a power check, refer to Sub-section 4C 'IN-SERVICE GROUND RUN - DRY'. Where an engine has been feathered for loss of torque pressure, the oil filters must be examined as described in Chapter 72-8, 'OIL SYSTEM - MAINTENANCE PRACTICES'. If satisfactory, the torque pressure transmitter system must be checked for serviceability, the engine ground run and the filters re-examined before the engine is accepted for further service.

B. If, after carrying out the appropriate checks given in this section, an engine is still rejected for high or low torque pressure it is possible that the engine has experienced a shift in torquemeter calibration; in this instance refer to 2.B. 'Torque calibration change (torque shift).

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Take-off torque low (without water/ methanol)	Instruments inaccurate	Fit Bourdon tube type pressure gauge and Foster potentiometer then carry out the relevant ground run-in Section 4.	If torque pressure and r.p.m. indicator are satisfactory and aircraft T.G.T. reading is the same as that of the Foster potentiometer and within the appropriate acceptance limits, change torque pressure transmitter and/or gauge. If low torque pressure is confirmed, suspect engine deterioration or torquemeter calibration change.
	Engine deterioration or torquemeter calibration change		(1) Check ENGINE pyrometry system, Chapter 77-2-1, 'THERMOCOUPLE AND HARNESS - MAINTENANCE PRACTICES'

Torque pressure faults (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Take-off torque low (without water/ methanol) (cont.)			(2) Clean the compressor, Chapter 72-3, 'COMPRESSOR - MAINTENANCE PRACTICES' (3) If torque pressure is still below acceptance limits, Sub-section 4.A. 'INSTALLATION GROUND RUN - DRY', reject engine; refer to 2.B. 'Torque calibration change (torque shift) (4) If mintorque and T.G.T. below operating limit, Sub-section 4C 'IN-SERVICE GROUND RUN - DRY', increase fuel flow to bring T.G.T. up to operating limit. If not effective, reject engine; refer to 2.A. 'T.G.T., torque, fuel flow and fuel datum.
with fluctuating r.p.m.	As under R.P.M. FAULTS, 'Fluctuating r.p.m. with falling T.G.T. and torque'		
with correct r.p.m. and low T.G.T.	As under T.G.T. FAULTS, 'T.G.T. low at 15,000 r.p.m. with low torque'		
with correct r.p.m. and high T.G.T.	As under T.G.T. FAULTS, 'T.G.T. high at 15,000 r.p.m. with satisfactory or low torque pressure'		

Torque pressure faults (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Take-off torque pressure low (using water/methanol)	Insufficient aircraft supply or faulty w/m check	If no indicator light suspect:	
		(a) Water/methanol supply filter	Aircraft Maintenance Manual, Chapters H2 - 'FUEL AND WATER/METHANOL SYSTEMS - REMOVAL AND INSTALLATION' or 82-20-1, - 'FILTER - MAINTENANCE PRACTICES'
		(b) Electrical supply	Chapters H3 (28-00) Aircraft Maintenance Manual 'FUEL AND WATER/METHANOL SYSTEMS - SERVICING AND MAINTENANCE'
		(c) Water/methanol tank pump	Aircraft Maintenance Manual Chapters H3 - 'FUEL AND WATER/METHANOL SYSTEMS - SERVICING AND MAINTENANCE' or 82-20-1, 'WATER/METHANOL PUMP - MAINTENANCE PRACTICES'
		If indicator light ON suspect electric water/methanol cock	Aircraft Maintenance Manual Chapter H1 'FUEL AND WATER/METHANOL SYSTEMS - DESCRIPTION' or 82-20-0, - 'WATER INJECTION - DISTRIBUTION - DESCRIPTION'

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Take-off torque pressure low (using water/ methanol) (cont.)	Water/methanol unit setting incorrect and/or torque pressure transmitter system defective	Fit bourdon tube type pressure gauge Ground run	Sub-section 4B, 'GROUND RUN - WET' If W.M.C.P. is now correct change transmitter Chapter 77-3-1 'TORQUEMETER PRESSURE TRANSMITTER - MAINTENANCE PRACTICES' and/or gauge; Aircraft Maintenance Manual - Chapter N3, 'INSTRUMENTS - TORQUE PRESSURE INDICATION' or 77-10-0, 'TORQUE PRESSURE INDICATION SYSTEM - MAINTENANCE PRACTICES'. If W.M.C.P. is incorrect, adjust as required
	Control setting incorrect	Check static engine control setting; ensure synchro system on datum	Chapter 76-0, 'ENGINE CONTROLS - MAINTENANCE PRACTICES'

Torque pressure faults (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Take-off torque pressure low (using water/ methanol) (cont.)	Water/methanol unit defective	Remove oil filter from unit	Clean or renew w/m unit oil filter, if required. If satisfactory change w/m unit, Chapter 82-1, 'WATER/METHANOL CONTROL UNIT - MAINTENANCE PRACTICES'. If unsatisfactory check engine main oil pressure filter and by-pass, Chapter 72-8, 'OIL SYSTEM - MAINTENANCE PRACTICES'.
Intermittent, slow, or no increase of torque pressure (using water/ methanol)	Water/methanol unit servo piston seal failure	After elimination of other causes listed under 'Take-off' torque pressure low (with w/m), suspect w/m unit servo piston seal	Change w/m unit, Chapter 82-1, 'WATER/METHANOL CONTROL UNIT - MAINTENANCE PRACTICES' or, if replacement unit not available, renew the servo piston seal; Chapter 82-1, 'WATER/ METHANOL CONTROL UNIT - MAINTENANCE PRACTICES'.
Torque pressure falls below 50 p.s.i. with high T.G.T. (propeller auto-coarsens)	Internal mechanical defect	Rotate engine by hand and check for freedom and unusual noises. Examine oil filters.	If examination unsatisfactory, remove engine and refer to 'Rough running'.
		Suspect low torque switch failure	Refer to 'Propeller system functional defects' - Auto coarsening defects'.
As above with low t.g.t.	Loss of fuel flow	Suspect: (a) Faulty fuel pump (b) F.C.U.	Chapter 73-0, 'ENGINE FUEL AND CONTROL - MAINTENANCE PRACTICES' Change fuel pump and F.C.U. in turn. Reject engine if pump drive faulty.

Torque pressure faults (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
As above with low T.G.T. (cont.)		Suspect fuel filter de-icing system not operating (blockage) and check:	Chapter 75-1-1, 'HOT-AIR VALVE - DESCRIPTION'.
		(a) Hot-air valve (b) Fuel pressure differential switch	If electrical system is satisfactory change hot-air valve, Chapter 75-1-1, 'HOT-AIR VALVE - MAINTENANCE PRACTICES'. Change fuel pressure differential switch Aircraft Maintenance Manual Chapter H1 - 'FUEL AND WATER/METHANOL SYSTEMS - DESCRIPTION' or 28-45-1, - 'FUEL DIFFERENTIAL PRESSURE SWITCH - MAINTENANCE PRACTICES'
		Suspect aircraft fuel system mismanagement or air locks	Bleed the fuel system Chapter 73-0, 'ENGINE FUEL AND CONTROL - MAINTENANCE PRACTICES'

Torque pressure faults (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
As above with low T.G.T. (cont.)	Engine flame-out	Suspect power unit ice protection and check system	
High torque pressure above torque pressure upper limit, without water/methanol	Instruments inaccurate	Fit Bourdon tube type pressure gauge and Foster potentiometer then carry out the relevant ground run in Section 4.	If torquemeter and r.p.m. indicator are satisfactory and engine T.G.T. reading is the same as that of the Foster potentiometer and within the appropriate acceptance limits, change the torquemeter transmitter, Chapter 77-3-1, 'TORQUEMETER PRESSURE TRANSMITTER - MAINTENANCE PRACTICES' and/or gauge, Aircraft Maintenance Manual Chapters N3, 'INSTRUMENTS - SERVICING AND MAINTENANCE' or 77-10-0 - 'TORQUE PRESSURE INDICATION SYSTEM - MAINTENANCE PRACTICES'

Torque pressure faults (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
High torque pressure, above torque pressure upper limit, without water/methanol (cont.)			If high torque pressure is confirmed, suspect torquemeter calibration change. Reject engine; refer to para.2.B.
Fluctuating torque pressure indication	Air in torquemeter pressure transmitter		Bleed the torquemeter pressure transmitter system, Chapter 77-3-1, 'TORQUEMETER PRESSURE TRANSMITTER - MAINTENANCE PRACTICES'
Sudden increase in torque pressure with T.G.T., fuel flow and fuel	Reduction gear defect	Examine oil filters	Chapter 72-8, 'OIL SYSTEM - MAINTENANCE PRACTICES'. If examination of oil filters indicates reduction gear failure, reject the engine
High torque pressure (above torque pressure limit) with T.G.T. fuel flow and fuel datum all normal	Water/methanol cock leaking	Disconnect the water/methanol feed pipe at the water/methanol unit and with water/methanol cock 'CLOSED' ensure that there is no water/methanol flow	If water/methanol flow is evident, change the water/methanol cock. Chapter H.3 - Aircraft Maintenance Manual - 'FUEL AND W/M SYSTEMS'

Torque pressure faults (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Fluctuating torque with similar conditions showing on r.p.m. and T.G.T. parameters	Flame tube swirler detached, disturbing combustion pattern	Remove combustion assemblies for inspection	Replace flame tubes as necessary, Chapter 72-5, 'COMBUSTION SECTION - MAINTENANCE PRACTICES'
Take-off torque pressure high (using water/methanol) with low injection 'cut-in' r.p.m.	Faulty combined drain valve causing valve to remain in permanently open position	Remove drain valve and check for carbon deposit on return spring and/or sealing faces	Clean or replace valve return spring and valve Chapter 71-1, 'FUEL DRAIN SYSTEM - MAINTENANCE PRACTICES'

Rough running

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Engine runs rough or makes unusual noise	Internal engine damage	Ensure freedom of rotation of engine	
		Examine L.P. turbine and exhaust unit for signs of cracking or other damage	Chapter 72-6, 'TURBINE AND NOZZLE BOX - MAINTENANCE PRACTICES'
		Examine combustion chamber air casings	Chapter 72-5, 'COMBUSTION SECTION - MAINTENANCE PRACTICES'
		Examine control levers on F.C.U. and P.C.U. for cracks	
		Examine oil filters	Chapter 72-8, 'OIL SYSTEM MAINTENANCE PRACTICES'
		Examine compressor rotating guide vanes	Chapter 72-3, 'COMPRESSOR - MAINTENANCE PRACTICES'
		Remove a combustion chamber and examine the H.P. nozzle guide vanes and the H.P. turbine	
		Examine for cracking generally and in particular: (a) Thermocouple junction box brackets and connections (may be indicated by fluctuating T.G.T. or excessively high or low T.G.T.)	If one component only is cracked, change it and re-examine combustion chambers, air casings, control levers on F.C.U. and P.C.U. and items (a) and (b) after 10 flying hours

Rough running (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Engine runs rough or makes unusual noise (cont.)		(b) Nozzle box heat shield (1) Accept cracks through the bolt holes of the heat shield provided they are confined to the mounting flange. (2) Accept radial cracks through the lightening holes to the inner edge of the mounting flange.	If two or more items of the same or different types (a) and (b) are cracked, reject engine
		(c) Firewire detector elements	If an isolated instance of cracking, change firewire Aircraft Maintenance Manual - Chapter Q 3, 'FIRE PROTECTION EQUIPMENT - SERVICING AND MAINTENANCE' or 26-10-0, - 'ENGINE FIRE DETECTION SYSTEM - MAINTENANCE PRACTICES'. If a second failure in the same locality occurs within 20 flying hours, for no apparent reason, reject the engine.

Rough running (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Engine runs rough or makes unusual noise (cont.)		(b) Nozzle box heat shield (1) Accept cracks through the bolt holes of the heat shield provided they are confined to the mounting flange. (2) Accept radial cracks through the lightening holes to the inner edge of the mounting flange.	If two or more items of the same or different types (a) and (b) are cracked, reject engine
		(c) Firewire detector elements	If an isolated instance of cracking, change firewire Aircraft Maintenance Manual - Chapter Q 3, 'FIRE PROTECTION EQUIPMENT - SERVICING AND MAINTENANCE' or 26-10-0, - 'ENGINE FIRE DETECTION SYSTEM - MAINTENANCE PRACTICES'. If a second failure in the same locality occurs within 20 flying hours, for no apparent reason, reject the engine.

Rough running (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Engine runs rough or makes unusual noise (cont.)	Propeller insecure, damaged or out of track	Check propeller and torque loading; if impact has occurred, check the engine for shock-loading	Chapter G2, (61-10-0), Aircraft Maintenance Manual - 'PROPELLER INSTALLATION - REMOVAL AND INSTALLATION'. If damage to the propeller necessitates its removal, reject the engine. If shock loading is slight, accept the engine if it rotates freely and the propeller does not require removal.
	Engine mountings insecure or auxiliary gearbox /accessories defective	Run engine with auxiliary gearbox disconnected. NOTE: Engine r.p.m. will not register.	If roughness persists, torque load power plant retaining bolts as instructed in Aircraft Maintenance Manual Chapter E2 - 'POWER PLANT - REMOVAL AND INSTALLATION - DESCRIPTION' or, 83-10-1, - 'DRIVE SHAFT - MAINTENANCE PRACTICES'. If roughness ceases, change auxiliary gearbox/associated accessories; Aircraft Maintenance Manual Chapter E 2, 'POWER PLANT - REMOVAL AND INSTALLATION', and Chapter E 3, Aircraft Maintenance Manual 'POWER PLANT - SERVICING AND MAINTENANCE' or 83-20-1 Aircraft Maintenance Manual - 'GEARBOX - MAINTENANCE PRACTICES'.
	Internal engine damage	As above	

Rough running (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Grating noise on start up or run down or engine is stiff to turn whilst rotating propeller during inspection	Turbine inter-stage seal rub (evident on a freedom of rotation check on a cold engine) NOTE: Turbine rubs evident only when the engine is turned opposite to the normal direction of rotation should be ignored, and should not cause the engine to be rejected.	Examine oil filters; if satisfactory, ground run at cruising r.p.m. for 10 minutes then shut down. Immediately propeller has stopped rotating carry out a freedom of rotation check. If seal rub still audible, repeat ground run ONCE and recheck rotational freedom	If with engine cold a rub is evident then, provided that the engine does not rub when rotated when hot, it may be considered serviceable.
	Auxiliary gearbox and/or accessories defective	Run engine with auxiliary gearbox disconnected. NOTE: Engine r.p.m. will not register.	If roughness ceases, change auxiliary gearbox/associated accessories; Aircraft Maintenance Manual - Chapter E 2., - 'POWER PLANT - REMOVAL AND INSTALLATION', and Chapter E3, Aircraft Maintenance Manual, - 'POWER PLANT - SERVICING AND MAINTENANCE' or 83-10-1, Aircraft Maintenance Manual 'DRIVE SHAFT - MAINTENANCE PRACTICES' Chapter 72-0, 'SERVICING - ENGINE AND ENGINE BAY INSPECTION'.
	Fuel pump stiction		

Rough running (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Grating noise on start up or run down or engine is stiff to turn whilst rotating propeller during inspection (cont.)	Failure of fuel burner shroud nut(s) indicated by turbine rub on a freedom of rotation check	NOTE: Fuel burners to Mod. 1625, Mod.1626 or S.B.Da73-68 standard need not be inspected. Remove and dismantle combustion chambers as instructed in Chapter 72-5, 'COMBUSTION SECTION - MAINTENANCE PRACTICES' sufficiently to inspect burner shrouds for cracks. If there is no evidence of cracks and symbols 'H' and 'C' are engraved on any adjacent serrations, accept burner as serviceable; record compliance of S.B.Da73-68 in engine log book. If symbols 'H' and 'C' are not observed or 'H' only is observed, refer to S.B.Da73-68.	
		If any shroud nuts are cracked	Inspect turbine for evidence of overheating as instructed in Chapter 72-6, 'TURBINE AND NOZZLE BOX - MAINTENANCE PRACTICES'; reject engine if inspection is unsatisfactory. If inspection is satisfactory, fit replacement burner to Mod.1625, 1626 or S.B.Da73-68 standard.

Oil system defects

A. To ensure stabilized conditions and consistent results, the check of the oil level in the tank and any topping-up required should be carried out between 10 and 30 minutes after shut-down. This procedure will obviate over or under-filling and will facilitate accurate recording of oil consumption.

B. If oil consumption exceeds $^1/_2$ Imp. pint per hour, possible leaks should be investigated and rectified as specified in the following chart.

C. It should be borne in mind that any static functioning of the propeller will affect the indicated oil level. If propeller functional checks are to be carried out, it is recommended that the oil by-pass equipment is fitted; Section 2, 'PROPELLER SYSTEM FUNCTIONAL CHECKS'.

D. Incorrect oil levels can be recorded as a result of oil remaining on the location section of the dipstick even when the oil tank is empty and care should be taken to ensure this false oil level indication does not invalidate any checks carried out. To establish accurate oil consumption values, when the oil level is below the calibrated part of the dipstick a known quantity of oil should be added until a reading is obtained; the oil consumption can then be calculated.

E. When an internal leak is suspected, oil in the compressor may be revealed by removal of the drain plug or examination of the hot-air outlet from the fuel heater.

F. If oil has leaked into the air intake, it is recommended that the compressor drain plug be removed to allow any oil which has collected to drain out, and that the compressor washing procedure, Chapter 72-3, 'COMPRESSOR - MAINTENANCE PRACTICES', para.2.B. be carried out immediately. An engine which has been run for any length of time with oil leaking into the intake is liable to deterioration as a result of oil hardening on the internal surfaces of the compressor. In this instance, it will be necessary to clean the compressor using the 'Soft blast method', Chapter 72-3, 'COMPRESSOR - MAINTENANCE PRACTICES', para.2.B.

Oil system defects (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
No oil pressure Low oil pressure Fluctuating oil pressure	Oil pressure indicator system defective	If low oil pressure warning light was extinguished, check oil pressure indicating system	Change gauge, Chapter N.2.(31) Aircraft Maintenance Manual, 'INSTRUMENTS - REMOVAL AND INSTALLATION' and/or oil pressure transmitter, Chapter 77-5-1 ,'OIL PRESSURE TRANSMITTER - MAINTENANCE PRACTICES'.
	Lack of oil	Check oil level	Re-fill oil tank, Chapter 72-8. 'OIL SYSTEM - MAINTENANCE PRACTICES'.
	Internal engine defect	Rotate engine by hand and check for freedom and unusual noise	Chapter 72-8, 'OIL SYSTEM - MAINTENANCE PRACTICES'. Reject engine if checks unsatisfactory.
		Examine oil filters	If satisfactory, ensure sufficient oil in tank then carry out 6 motoring cycles, Section 3 'STARTING, MOTORING AND STOPPING DRILLS', and if oil pressure is registered and/ or low pressure oil warning light goes out, carry out ground run Sub-section 4C 'IN-SERVICE GROUND RUN - DRY' Action E.
	Oil pressure relief valve defective	Remove and examine oil relief valve	Chapter 72-8, 'OIL SYSTEM - MAINTENANCE PRACTICES'. Clean and lap valve seatings or fit serviceable assembly. Ground run, Sub-section 4C 'IN-SERVICE GROUND RUN - DRY'.

Oil system defects (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Erratic oil temperature	Temperature indicator system defective	Examine all electrical connections in system	)Repair/replace as required)If satisfactory change gauge,)Chapter N2, (Chapter 31))Aircraft Maintenance Manual,)'INSTRUMENTS - REMOVAL AND)INSTALLATION' and/or)temperature bulb, Chapter)77-4-1, 'OIL TEMPERATURE)TRANSMITTER - MAINTENANCE)PRACTICES'.
Oil temperature high	Temperature indicator system defective	Examine all electrical connections in system	
	Blocked air passage in cooler matrix	Examine with spotlight, from the rear	Chapter 72-8, 'OIL SYSTEM MAINTENANCE PRACTICES'
	Oil cooler by-pass valve stuck in OPEN position	Remove and check valve	Clean and lap, if required, Chapter 72-8, 'OIL SYSTEM MAINTENANCE PRACTICES'
	Internal engine defect	Rotate engine by hand) and check for freedom)) Examine oil filters)	Reject engine if examination is unsatisfactory
	Combustion chamber air casing(s) burned through	Examine combustion chamber air casings and engine intermediate casing for indications of burning	Reject engine if it is considered that air casing(s) failure is secondary to engine internal failure or if intermediate casing is burned

Oil system defects (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Oil temperature low (excessive warming-up period)	Temperature indicator system defective	Examine all electrical connections in system	Repair/replace as required. If satisfactory change gauge, Chapter N2, (Chapter 31) Aircraft Maintenance Manual 'INSTRUMENTS - REMOVAL AND INSTALLATION' and/or temperature bulb Chapter 77-4-1 'OIL TEMPERATURE TRANSMITTER - MAINTENANCE PRACTICES'
Oil consumption exceeds $^{1}/2$ Imp.pt./hr.	External leakage	Examine exterior of power unit, including all accessories, and propeller for evidence of excessive oil leakage	After rectification, re-fill oil tank before ground running Chapter 72-8, 'OIL SYSTEM - MAINTENANCE PRACTICES'. If oil level has fallen below dipstick end or oil has leaked into intake, refer to A. to F.
	Internal leakage	Refer to A. to F.	
		Rotate engine by hand) and check for freedom) Examine oil filters)	Reject engine if examination unsatisfactory, Chapter 72-8, 'OIL SYSTEM - MAINTENANCE PRACTICES'
		Keep close check on subsequent oil consumption	Reject engine if consumption exceeds 1 Imp. pt./hr.

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Increase in oil level	1. Incorrect filling procedure	Refer to general notes, A to F preceding this table	
	2. Fuel leaking from fuel pump drive shaft seal	Check oil for fuel contamination. Fuel odour will be apparent in cases of significant leakage	Change fuel pump, Chapter 73-2 'FUEL PUMP - MAINTENANCES PRACTICES' Drain and replenish the oil system, Chapter 72-8, 'OIL SYSTEM - MAINTENANCE PRACTICES' Fit by-pass equipment and carry out a feathering cycle three times, Chapter 71-0, Sub-section 2, 'PROPELLER SYSTEM FUNCTIONAL CHECKS' Motor the engine (blow out cycle), Chapter 71-0, Sub-section 3, 'ENGINE STARTING, MOTORING AND STOPPING DRILLS' Drain and replenish the oil system again Examine oil filters every 25 hours for the next 100 engine hours, Chapter 72-8, 'OIL SYSTEM - MAINTENANCE PRACTICES'

Miscellaneous defects (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Failure to re-light in flight	Igniter system	Carry out audible check on H.E. igniter	If unsatisfactory, check electrical circuit, if this is satisfactory, change High Energy Ignition unit, Aircraft Maintenance Manual Chapter J.2 'ELECTRICAL INSTALLATION - REMOVAL AND INSTALLATION' or 74-00 - 'IGNITION SYSTEM - MAINTENANCE PRACTICES' and/or Igniter plugs, Chapter 80-2, 'IGNITER PLUGS AND LEADS - MAINTENANCE PRACTICES'.
Flame in exhaust on shut-down	Incorrect H.P. cock control setting	Check engine control static settings	Chapter 76-0, 'CONTROL SYSTEM - MAINTENANCE PRACTICES'.
Fuel drainage from engine main drain exceeds 5 c.c. per min., with tank pumps on the H.P. cock shut	Excessive leakage from F.C.U. and/or fuel pump	Disconnect drain at F.C.U. and measure leak rate from each unit	If leak from either unit alone exceeds 5 c.c. per minute, reject unit. Before rejecting a suspected F.C.U., ensure engine control static settings are correct (H.P. cock lever is between SHUT engravings on unit; leakage may sometimes be cured by resetting lever towards SHUT line nearest to FEATHER), Chapter 76-0, 'CONTROL SYSTEM - MAINTENANCE PRACTICES'.
Fuel filter icing warning light 'ON' in flight	Blockage or partial blockage of L.P. fuel filter by ice or contamination	Check aircraft fuel system for water content	Chapter 73-3, 'FUEL CONTROL UNIT - MAINTENANCE PRACTICES'

Miscellaneous defects (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Fuel filter icing warning light 'ON' in flight (cont.)		Check fuel filter	Chapter 73-3, 'FUEL CONTROL UNIT - MAINTENANCE PRACTICES'.
	Defective fuel pressure differential switch or electrical circuit	Check operation of fuel pressure differential switch Check electrical circuit	'Aircraft Maintenance Manual' - Chapter H 3, 'FUEL AND WATER/METHANOL SYSTEMS - SERVICING AND MAINTENANCE', or 28-45-1, - 'FUEL DIFFERENTIAL PRESSURE SWITCH - MAINTENANCE PRACTICES'

Propeller system functional defects

A. Propeller auto-coarsening, or pitch coarsening from the operation of the electro-hydraulic stop on the ground, where applicable, can result in the T.G.T. limitations being exceeded, even with only idling fuel flow; refer to Section 1, 'ENGINE HANDLING'.

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Flight fine pitch stop defects In flight (F.F.P.S. lever at ENGAGED)			
Flight fine pitch stop withdrawn lamp came on in flight	F.F.P.S. withdrawal circuit partially armed	Check F.F.P.S. lever switches and stop withdrawal circuit	Aircraft Maintenance Manual Chapter G.3, 'PROPELLER INSTALLATION - SERVICING AND MAINTENANCE' or 61-20-0 - 'PROPELLER CONTROL - MAINTENANCE PRACTICES'
Electro-hydraulic stop operated in flight (intermittent flight on/off of propeller below F.F.P.S. lamp) one propeller affected	F.F.P.S. ineffective because of mechanical defect	Carry out propeller functional checks	Section 2, Action 5, 'PROPELLER SYSTEM FUNCTIONAL CHECKS' (ENGINE STATIONARY) Change propeller, Chapter G2, (61-10-0) Aircraft Maintenance Manual 'PROPELLER INSTALLATION - REMOVAL AND INSTALLATION'. P.C.U., Chapter 61-1, 'PROPELLER CONTROLLER UNIT - MAINTENANCE PRACTICES'
On ground (F.F.P.S. lever at WITHDRAWN)		Check switches and stop withdrawal circuit	As required, Aircraft Maintenance Manual, Chapter G.3 'PROPELLER INSTALLATION - SERVICING AND MAINTENANCE' or 61-20-0, - 'PROPELLER CONTROL - MAINTENANCE PRACTICES'
Propeller below F.F.P.S. lights remained OFF and T.G.T. rose rapidly on throttling back on the ground, with F.F.P.S. withdrawn lamp on or off (both engines affected)	F.F.P.S. withdrawal circuit not energized because of defective F.F.P.S. lever switch(es) or switch linkage or other circuit defect		

Propeller system functional defects (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
As above with F.F.P.S. withdrawn lamp on (one engine affected)	P.C.U. or electrical circuit defective	Carry out propeller functional checks Check electrical circuit	Section 2, Action 5, 'PROPELLER SYSTEM FUNCTIONAL CHECKS' (ENGINE STATIONARY) As required, Aircraft Maintenance Manual Chapter G3, 'PROPELLER INSTALLATION - SERVICING AND MAINTENANCE' or 61-20-0 - 'PROPELLER CONTROL - MAINTENANCE PRACTICES'
	Propeller defective		Change P.C.U., Chapter 61-1, 'PROPELLER CONTROLLER UNIT - MAINTENANCE PRACTICES'. Change propeller, Chapter G2, (61-10-0) Aircraft Maintenance Manual, 'PROPELLER INSTALLATION - REMOVAL AND INSTALLATION'.
Electro-hydraulic stops defects on ground (F.F.P.S. lever at WITHDRAWN)			
Electro-hydraulic stop operative on ground intermittent ON/OFF of propeller below F.F.P.S. lamp with F.F.P.S. withdrawn lamp on (affecting one propeller)	Electro-hydraulic stop isolating switch defective	Propeller functional checks Check switch	Section 2, Action 5. 'PROPELLER SYSTEM FUNCTIONAL CHECKS' (ENGINE STATIONARY) Aircraft Maintenance Manual Chapter G.3., 'PROPELLER INSTALLATION - SERVICING AND MAINTENANCE', or 61-20-0, - 'PROPELLER CONTROL - MAINTENANCE PRACTICES'

Propeller system functional defects (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Auto-coarsening defects in-flight - throttle at cruising r.p.m. or above	Auto-coarsening circuit not completed	Propeller functional checks	Section 2, Action 4, 'PROPELLER SYSTEM FUNCTIONAL CHECKS' (ENGINE STATIONARY)
Propeller would not auto coarsen when torque dropped below 50 p.s.i.	Defective low torque switch	Check operation of low torque switch	Change low torque switch, Chapter 82-2, 'LOW TORQUE SWITCH - MAINTENANCE PRACTICES'
	Defective or incorrectly set throttle and/or H.P. cock control linkage micro-switches	Check operation of micro-switches and position	Aircraft Maintenance Manual Chapter F.3, 'POWER PLANT CONTROLS - SERVICING AND MAINTENANCE', or 76-11-0, - 'HIGH PRESSURE FUEL VALVE CONTROL - MAINTENANCE PRACTICES'
	Defective electrical circuit	Check electrical system	As required, Aircraft Maintenance Manual Chapter G.3, 'PROPELLER INSTALLATION - SERVICING AND MAINTENANCE', or 61-20-0, - 'PROPELLER CONTROL - MAINTENANCE PRACTICES'.
In flight or on ground			
Propeller auto; coarsened without loss of torque and with rise in T.G.T. (throttle at cruising r.p.m. or above)	Auto-coarsening circuit completed incorrectly	Propeller functional checks	Section 2, Action 4, 'PROPELLER SYSTEM FUNCTION CHECKS' (ENGINE STATIONARY)

Propeller system functional defects (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Propeller auto-coarsened without loss of torque and with rise in T.G.T. (throttle at cruising r.p.m. or above) (cont.)	Defective low torque switch	Check operation of low torque switch	Change low torque switch, Chapter 82-2, 'LOW TORQUE SWITCH - MAINTENANCE PRACTICES'
	Defective electrical circuit	Check auto-coarsening electrical circuit refer to 10.A.	As required, Aircraft Maintenance Manual Chapter G.3 'PROPELLER INSTALLATION - SERVICING AND MAINTENANCE' or 61-20-0, 'PROPELLER CONTROL - MAINTENANCE PRACTICES'
on ground			
Propeller auto-coarsened on throttling back to idling (i.e. when low torque pressure falls below 50 p.s.i., low torque switch closed	Defective or incorrectly positioned throttle micro-switch	Propeller functional checks	Section 2, Action 4, 'PROPELLER SYSTEM FUNCTIONAL CHECK' (ENGINE STATIONARY)
		Check operation of throttle micro-switch and position	Aircraft Maintenance Manual - Chapter F.3, 'POWER PLANT CONTROLS - SERVICING AND MAINTENANCE' or 76-11-0, - 'HIGH PRESSURE FUEL VALVE CONTROL - MAINTENANCE PRACTICES'
Feathering defects			
In flight or on ground			
Propeller will not feather with feathering current warning lamp on	Feathering motor supply	Check electrical supply to feathering motor	As required, Aircraft Maintenance Manual Chapter G.3 'PROPELLER INSTALLATION - SERVICING AND MAINTENANCE' or 61-20-0 - 'PROPELLER CONTROL - MAINTENANCE PRACTICES'
	Feathering pump and/or motor defective	Audible check with feathering pump switch ON	Change feathering pump unit, Chapter 61-2, 'FEATHERING PUMP - MAINTENANCE PRACTICES'

Propeller system functional defects (cont.)

SYMPTOM	POSSIBLE CAUSE	INVESTIGATION	RECTIFICATION
Propeller will not feather with feathering current warning lamp on (cont.)	P.C.U. or propeller defective	If above checks satisfactory	Change P.C.U., Aircraft Maintenance Manual Chapter G.2 'PROPELLER INSTALLATION - REMOVAL AND INSTALLATION' or 61-20-0, 'PROPELLER CONTROL - MAINTENANCE PRACTICES' Change propeller, Aircraft Maintenance Manual, Chapter G.2, 'PROPELLER INSTALLATION - REMOVAL AND INSTALLATION', or 61-20-0, 'PROPELLER CONTROL - MAINTENANCE PRACTICES'
As above, manual feather only	Mal-adjusted H.P. cock control	Carry out H.P. cock and feathering controls static check	Aircraft Maintenance Manual F.3, 'POWER PLANT CONTROLS - SERVICING AND MAINTENANCE' or 76-11-0, - 'HIGH PRESSURE FUEL VALVE CONTROL - MAINTENANCE PRACTICES'
As above, with feathering circuit warning lamp out	Feathering control electrical circuit defective	Check electrical circuit	As necessary, Aircraft Maintenance Manual Chapter G.1 'PROPELLER SYSTEM - DESCRIPTION' or 61-20-0, 'PROPELLERS - CONTROLLING - DESCRIPTION'

POWER PLANT - ADJUSTMENT/TEST

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INTRODUCTION

1. General

A. The instructions contained in this page block (501) detail the procedures to be followed when ground running the Dart engine to ensure that the engine and propeller systems are functioning correctly.

B. The pages have been divided into sections and, to facilitate easy reference, each section is separated by a buff coloured tabbed divider card identified as follows:

(1) ENGINE HANDLING (page 511/1)

Contains the instructions for engine handling, fire drills and operating limitations.

(2) PROPELLER SYSTEM FUNCTIONAL CHECKS (page 521/1)

Contains the complete sequence of static checks necessary to function check the propeller system.

(3) ENGINE STARTING, MOTORING AND STOPPING DRILLS (page 531/1)

Contains the complete sequence of drills for starting, motoring and stopping the engine.

(4) ENGINE GROUND RUNNING PROCEDURES (page 541/1)

Contains the information for ground running procedures together with check lists which detail:

(a) WHEN a ground running procedure is required.

(b) WHAT checks must be carried out during the ground running procedure.

(c) WHERE the relevant instructions for the particular ground running procedure are located in the manual.

Section 4 is further divided into 5 sub-sections and, to facilitate easy reference, each sub-section is separated by a pink coloured tabbed divider card identified as follows:

4A INSTALLATION GROUND RUN - DRY (page 551/1)

Contains the instructions for an installation ground run and, together with a worked example, explains the calculations required to determine the performance of the engine for future in-service use.

Power plant - Adjustment/test (cont.)

4B GROUND RUN - WET (page 561/1)

Contains the instructions for a water/methanol power check.

4C IN-SERVICE GROUND RUN - DRY (page 571/1)

Contains the full instructions for an in-service ground run,any part of which may be used as required, and together with a worked example explains the calculations required to determine the performance of the engine for further in-service use.

4D REMOVAL/RE-INSTALLATION GROUND RUN - DRY (page 581/1)

Contains the instructions for the removal and re-installation ground-runs of a part-life engine together with worked examples which explain the calculations required to determine the performance of the engine for further in-service use.

4E CHARTS (page 591/1)

Contains all the Correction charts necessary to carry out any of the ground runs outlined above.

ENGINE HANDLING

1. List of abbreviations

A. The following list gives the meanings of the abbreviations used throughout this chapter.

C.	Centigrade	P.A.	pressure altitude
E.P.C.P.	engine power check pressure	P.C.U.	propeller controller unit
F.	Fahrenheit	p.s.i.	pounds per square inch
F.C.U.	fuel control unit	r.p.m.	revolutions per minute
F.F.P.S.	flight fine pitch stop	S.B.	Service Bulletin
ft.	feet	S.H.P.	shaft horse-power
G.P.C.P.	ground power check pressure	S.L.	sea level
I.S.A.	International standard atmosphere	T/O	Take-off
		T.P.U.L.	Torque pressure upper limit
Max.	maximum	T.V.	throttle valve
Mk.	Mark	T.G.T.	turbine gas temperature
Min.	minimum	w/m	water/methanol
Mod.	modification	W.M.C.P.	water/methanol check pressure
O.A.T.	outside air temperature	W.M.C.U.	water/methanol control unit
O.I.T.	oil inlet temperature		

2. General

A. Keep ground running to a minimum. Avoid unnecessary starts, rapid changes in engine conditions and non-essential running at high turbine gas temperatures.

B. If possible, avoid making control interconnection runs or power checks in fog, rain, strong cross-winds or strong tail-winds, because the results will be incorrect. If engine runs have to be carried out in adverse weather conditions they must be repeated at the first opportunity in acceptable conditions, and action taken to correct as necessary r.p.m. and T.G.T. settings, and mintorque.

C. It is not necessary to make corrections for humidity if the outside air temperature is below 10 degrees C.

D. Because propeller malfunction may cause excessive T.G.T. and severe damage to the turbine assembly, it is essential that the propeller system functional checks, detailed in Section 2, 'PROPELLER SYSTEM FUNCTIONAL CHECKS' are carried out before running an engine after installation or after any of the following:

(1) Propeller controller unit change.

(2) Propeller or associated parts change.

(3) Any disturbance of the high pressure fuel cock/propeller feathering controls.

(4) Any disturbance of the propeller controls, either mechanical or electrical.

(5) At the prescribed inspection periods; refer to Chapter 89-4, 'INSPECTION PERIODS'.

E. Do not exceed the engine Operating Limitations. The engine Operating Limitations are based on the results of the engine certification tests, and are the maxima that have been approved by the Airworthiness Authorities.

(1) The appropriate Operating Limitations are illustrated in this sub-section in the form in which they should appear in the aircraft crew compartment.

(2) The appropriate Operating Limitations also appear in the Aircraft Crew Manual and the Rolls-Royce Operating Instructions Manual.

F. The Recommended Operating Conditions, which represent less severe conditions than the Operating Limitations, are agreed between Rolls-Royce and the operator taking into account such factors as the required aircraft performance, the nature of the routes flown and the overhaul life of the engines. These Recommended Operating Conditions are contained in the Aircraft Crew Manual and the Rolls-Royce Operating Instructions and they should be listed in the aircraft crew compartment. Keep within these conditions for all ground running when engine r.p.m. and not power is the criterion.

3. Fairchild Friendship

A. Engine controls

(1) Set the FUEL DATUM using the fuel trimmers.

(a) The engine controls are interconnected to supply the amount of fuel necessary to achieve the correct take-off T.G.T. at the correct take-off r.p.m. and consequently the correct power at sea-level on an I.S.A. day.

(b) When either the O.A.T. or P.A. is increased, the mass of air flowing through the engine is reduced, therefore, if the fuel flow remained constant, excessive T.G.T. would result. To maintain T.G.T. within the operating limitations of the engine, in O.A.T. above I.S.A., a control (FUEL TRIMMER) is used to proportionally reduce the fuel flow at any given position of the POWER LEVER. Changes in P.A. are automatically compensated for by a capsule in the F.C.U.

(c) The fuel trimmer control is so designed that the fuel flow/T.G.T. can be varied without affecting the r.p.m. provided the POWER LEVER is within the constant speed range. It comprises an electrical actuator which operates the fuel trimmer pick-up lever on the engine control box. This is linked by a system of levers and rods, within the control box, to vary the F.C.U. throttle valve position.

(d) The fuel trimmer actuator is controlled by a 3-way switch, INCREASE - OFF - DECREASE, and the amount of fuel trimming selected is read as a percentage from a FUEL DATUM indicator, e.g.

(i) 100 per cent (FULL INCREASE) = No reduction in fuel flow.

(ii) 0 per cent (FULL DECREASE) = Maximum reduction in fuel flow.

(e) The correct fuel trimmer setting to give acceptable take-off power within T.G.T. limits, according to prevailing ambient conditions, is calculated from the fuel trimmer charts located in Sub-section 4E, 'CHARTS'. The fuel trimmer is also used to maintain the T.G.T. within the Operating Limitations at all flight conditions.

(f) Because the fuel trimmer is used to set the fuel flow, and thus control the engine performance, it is essential that the fuel trimmer datum controls are set correctly.

(g) To ensure consistent results when carrying out interconnection runs or power checks, always set the fuel datum indicator from a lower value.

Power plant - Adjustment/test (cont.)

(h) There are four modification standards of fuel trimmer and it is essential that the correct fuel trimmer chart is used during the calculations. The modification standards and associated charts are:

(i) Pre-Mod.1371 (Charts 1B and 2B)) All engine Mks.
) except Mk.532-7N,
This is the basic Dart fuel trimmer range) 532-7P, 536-7P
) and Mk.536-7R
(ii) Mod.1371 (Charts 1C and 2C))

Increased fuel trimmer angular range to enable the cruise T.G.T. to be kept within limitations in high ambient temperatures. Engines to pre-Mod. and Mod.1371 standard may be installed in the same aircraft but, the fuel trimmer controls must be set to the pre-Mod.1371 angular range; refer to Chapter 76, 'ENGINE CONTROLS - MAINTENANCE PRACTICES'.

(iii) Mod.1371 (Charts 1D and 2D)

As (ii) above but applicable to Mk.532-7N and Mk.532-7P only.

(iv) Mod.1706 (Charts 1E and 2E)

Applicable to Mk.536-7P and Mk.536-7R only.

To achieve the intermediate contingency rating the fuel trimmer controls are set to give I.S.A. sea level maximum take-off fuel flow at 85 per cent.

The increment of fuel trimmer control between 85 per cent and 100 per cent (FULL INCREASE) provides the additional fuel flow and hence power for the intermediate contingency rating.

CAUTION: 1. DO NOT GROUND RUN ENGINES AT FUEL DATUM POSITIONS IN EXCESS OF 85 PER CENT, BECAUSE IT MAY CAUSE OVERHEATING OF THE TURBINE.

2. IF A PRE-MOD.1706 ENGINE IS DEFICIENT OF FUEL TRIMMER RANGE IN CRUISE, THE MAXIMUM FUEL FLOW SETTING MUST NOT BE REDUCED.

(2) POWER LEVER and HIGH PRESSURE FUEL COCK movement

(a) With the engine stationary, advancing the POWER LEVER into the cruising range when both HIGH PRESSURE FUEL VALVE CONTROL levers are at OPEN or LOCK OUT (EMER OUT) will cause the auto-feathering (auto-coarsening) circuit to be completed through the low torque switch. The propeller will auto-feather, unless the appropriate circuit breaker is tripped or the HIGH PRESSURE FUEL VALVE CONTROL lever on the other engine is at SHUT or FEATHER.

(b) Exercise particular care in POWER LEVER handling if engine r.p.m. synchronizers are fitted, as undue force applied at either end of the slave engine POWER LEVER travel can disturb the synchronizer motor datum setting with resultant inaccuracies in maximum r.p.m. and idling checks. The synchronizer should normally be switched off when ground running for engine serviceability checks. It is essential to ensure that the synchronizer motor is on datum when adjusting or checking controls; refer to Chap.76-0 'ENGINE CONTROLS - MAINTENANCE PRACTICES'.

(d) Rapid acceleration from minimum constant speed r.p.m. to Take-off r.p.m. or rapid deceleration from Take-off r.p.m. to minimum constant speed r.p.m. can produce high propeller blade stresses when the aircraft is stationary. Open or close the POWER LEVERS smoothly and progressively through these ranges so that the rate of movement does not take less than 5 seconds to accomplish; exercise particular care between 14,000 r.p.m. and 15,000 r.p.m.

(e) When accelerating to Take-off conditions the engine r.p.m. may rise slightly above the maximum permissible, but should soon settle within the limitations. When throttling back, the engine will underspeed slightly before settling to the newly selected r.p.m. while the turbine gas temperature will first rise and then fall gradually to the value corresponding to the engine r.p.m.

CAUTION: UNDER THE CONDITIONS SPECIFIED IN (f) BELOW, IF THE ILLUMINATION OF THE FEATHERING PUMP LIGHT IS ACCOMPANIED BY A DECREASE IN R.P.M., A RAPID INCREASE IN T.G.T. AND AN INCREASE IN PROPELLER NOISE VOLUME, THE FAILURE OF THE LOW PRESSURE TORQUE SWITCH MAY HAVE OCCURRED. IMMEDIATELY CLOSE THE POWER LEVER AND SHUT THE HIGH PRESSURE FUEL COCK WITHOUT DELAY.

(f) If the POWER LEVER of a running engine is advanced rapidly, there may be insufficient torque pressure (approximately 50 p.s.i.) to open the low torque switch contacts before the auto-feathering circuit is completed. In this event the propeller will momentarily start to auto-feather (feathering pump warning light illuminated) until the torque pressure rises sufficiently, due to the increasing thrust transmitted by the coarsening propeller, to open the low torque switch contacts and break the auto-feathering circuit.

CAUTION: DO NOT OPEN THE THROTTLE TO RESTORE R.P.M. IF THE CONDITIONS SPECIFIED IN (g) OCCUR.

(g) Monitor the turbine gas temperature at all times when decelerating an engine, especially when the throttle is selecting r.p.m. below minimum constant speed (11,000 r.p.m.). Move the high pressure fuel valve control lever to OFF immediately, if under these conditions the turbine has temperature increases and the r.p.m. reduces rapidly, without POWER LEVER movement, as this will indicate that the propeller is not reaching ground fine pitch.

(h) Only one POWER LEVER at a time can be advanced to the full power position when the GUST LOCK lever is in the LOCK position.

Power plant - Adjustment/test (cont.)

B. Propeller system

(1) For all engine starting, the propeller must be on its ground fine pitch stop; this is indicated when the appropriate marks on the spinner and blades are aligned.

CAUTION: (1) 'THE FLIGHT FINE UNLOCKED' AND 'FLIGHT SAFE UNLOCKED' LIGHTS SHOULD BE ILLUMINATED DURING ALL GROUND RUNNING.

(2) FOR ALL GROUND RUNNING, POSITION THE HIGH PRESSURE FUEL VALVE CONTROL LEVER TO 'LOCK OUT' TO PREVENT (IN THE EVENT OF AN ELECTRICAL FAULT) ANY POSSIBILITY OF THE PROPELLER BEING RETAINED ON THE FLIGHT SAFETY PITCH STOP WHEN REDUCING ENGINE R.P.M.

(2) The GUST LOCK control handle must be at the LOCK position for all ground running to ensure that:

(a) Ground fine pitch is available, and that the electro-hydraulic stop is isolated for both propellers.

(b) The POWER LEVERS of both engines cannot be advanced together beyond taxying r.p.m. (a manual selector on the control pedestal allows either engine to be run at maximum r.p.m. provided the other engine POWER LEVER is at IDLE).

C. Engine fire drill

WARNING: DO NOT RESTART THE ENGINE OR PLACE THE HIGH PRESSURE FUEL VALVE CONTROL LEVER IN THE OPEN POSITION AFTER A FIRE WARNING UNTIL THE CAUSE OF THE FIRE WARNING HAS BEEN TRACED AND RECTIFIED.

(1) If the starter motor is running put the engine START SELECTOR switch to SAFE.

(2) Feather the propeller of the affected engine.

(a) HIGH PRESSURE FUEL VALVE CONTROL lever	Select FEATHER (this also shuts off fuel and water/methanol)
(b) FEATHERING button	PUSH until button remains in (2 secs. approx)
(c) Fuel Shut off valve 'T' handle	Pull during feathering operation or as soon as possible after closing HIGH PRESSURE FUEL COCK control lever

(3) When feathering drill is complete and if fire persists:

(a) Fire extinguisher switch	Select 'SHOT 1' first. If fire persists select 'SHOT 2'

NOTE: If the other engine is running, the propeller of this engine must also be feathered to facilitate ground fire fighting.

4. Fokker Friendship

A. Engine controls

(1) Set the FUEL DATUM using the fuel trimmers.

(a) The engine controls are interconnected to supply the amount of fuel necessary to achieve the correct take-off T.G.T. at the correct take-off r.p.m. and consequently the correct power at sea-level on an I.S.A. day.

(b) When either the O.A.T. or P.A. is increased, the mass of air flowing through the engine is reduced, therefore, if the fuel flow remained constant, excessive T.G.T. would result. To maintain T.G.T. within the operating limitations of the engine, in O.A.T. above I.S.A., a control (FUEL TRIMMER) is used to proportionally reduce the fuel flow at any given position of the R.P.M. CONTROL HANDLE. Changes in P.A. are automatically compensated for by a capsule in the P.C.U.

(c) The fuel trimmer control is so designed that the fuel flow/T.G.T. can be varied without effecting the r.p.m. provided the R.P.M. CONTROL HANDLE is within the constant speed range. It comprises an electrical actuator which operates the fuel trimmer pick-up lever on the engine control box. This is linked by a system of levers and rods, within the control box, to vary the F.C.U. throttle valve position.

(d) The fuel trimmer actuator is controlled by a 3-way switch, INCREASE - OFF - DECREASE, and the amount of fuel trimming selected is read as a percentage from a FUEL DATUM indicator, e.g.

(i) 100 per cent (FULL INCREASE) = No reduction in fuel flow.

(ii) 0 per cent (FULL DECREASE) = Maximum reduction in fuel flow.

(e) The correct fuel trimmer setting to give acceptable take-off power within T.G.T. limits, according to prevailing ambient conditions, is calculated from the fuel trimmer charts located in Sub-section 4E, 'CHARTS'. The fuel trimmer is also used to maintain the T.G.T. within the Operating Limitations at all flight conditions.

(f) Because the fuel trimmer is used to set the fuel flow, and thus control the engine performance, it is essential that the fuel trimmer datum controls are set correctly.

(g) To ensure consistent results when carrying out interconnection runs or power checks, always set the fuel datum indicator from a lower value.

Power plant - Adjustment/test (cont.)

(h) There are four modification standards of fuel trimmer and it is essential that the correct fuel trimmer chart is used during the calculations. The modification standards and associated charts are:

(i) Pre-Mod.1371 (Charts 1B and 2B)

This is the basic Dart fuel trimmer range

(ii) Mod.1371 (Charts 1C and 2C)

) All engine Mks. except Mk.532-7N, 532-7P, 536-7P and Mk.536-7R

Increased fuel trimmer angular range to enable the cruise T.G.T. to be kept within limitations in high ambient temperatures. Engines to pre-Mod. and Mod.1371 standard may be installed in the same aircraft but, the fuel trimmer controls must be set to the pre-Mod.1371 angular range; refer to Chapter 76, 'ENGINE CONTROLS - MAINTENANCE PRACTICES'.

(iii) Mod.1371 (Charts 1D and 2D)

As (ii) above but applicable to Mk.532-7N and Mk.532-7P only.

(iv) Mod.1706 (Charts 1E and 2E)

Applicable to Mk.536-7P and Mk.536-7R only.

To achieve the intermediate contingency rating the fuel trimmer controls are set to give I.S.A. sea level maximum take-off fuel flow at 85 per cent.

The increment of fuel trimmer control between 85 per cent and 100 per cent (FULL INCREASE) provides the additional fuel flow and hence power for the intermediate contingency rating.

CAUTION: 1. DO NOT GROUND RUN ENGINES AT FUEL DATUM POSITIONS IN EXCESS OF 85 PER CENT, BECAUSE IT MAY CAUSE OVERHEATING OF THE TURBINE.

2. IF A PRE-MOD.1706 ENGINE IS DEFICIENT OF FUEL TRIMMER RANGE IN CRUISE, THE MAXIMUM FUEL FLOW SETTING MUST NOT BE REDUCED.

(2) R.P.M. CONTROL HANDLE and H.P.C. CONTROL HANDLE movement

(a) With the engine stationary, advancing the R.P.M. CONTROL HANDLE into the cruising range when both H.P.C. CONTROL HANDLES are at OPEN or LOCK OUT will cause the auto-feathering (auto-coarsening) circuit to be completed through the low torque switch. The propeller will auto-feather, therefore, unless the appropriate circuit breaker is tripped or the H.P.C. CONTROL lever on the other engine is at SHUT or FEATHER.

(b) Exercise particular care in R.P.M. CONTROL HANDLE OPERATION if engine r.p.m. synchronizers are fitted, as undue force applied at either end of the slave engine R.P.M. CONTROL HANDLE travel can disturb the synchronizer motor datum setting with resultant inaccuracies in maximum r.p.m. and idling checks. The synchronizer should normally be switched off when ground running for engine serviceability checks. It is essential to ensure that the synchronizer motor is on datum when adjusting or checking controls; refer to Chap.76-0, 'ENGINE CONTROLS - MAINTENANCE PRACTICES'.

(c) Rapid acceleration from minimum constant speed r.p.m. to Take-off r.p.m. or rapid deceleration from Take-off r.p.m. to minimum constant speed r.p.m. can produce high propeller blade stresses when the aircraft is stationary. Open or close the R.P.M. CONTROL HANDLES smoothly and progressively through these ranges so that the rate of movement does not take less than 5 seconds to accomplish; exercise particular care between 14,000 r.p.m. and 15,000 r.p.m.

(d) When accelerating to Take-off conditions the engine r.p.m. may rise slightly above the maximum permissible, but should soon settle within the limitations. When throttling back, the engine will underspeed slightly before settling to the newly selected r.p.m. while the turbine gas temperature will first rise and then fall gradually to the value corresponding to the engine r.p.m.

CAUTION: UNDER THE CONDITIONS SPECIFIED IN (e) BELOW, IF THE ILLUMINATION OF THE FEATHERING PUMP LIGHT IS ACCOMPANIED BY A DECREASE IN R.P.M., A RAPID INCREASE IN T.G.T. AND AN INCREASE IN PROPELLER NOISE VOLUME, THE FAILURE OF THE LOW PRESSURE TORQUE SWITCH MAY HAVE OCCURRED. IMMEDIATELY CLOSE THE R.P.M. CONTROL HANDLE AND SHUT THE H.P.C. CONTROL HANDLE WITHOUT DELAY.

(e) If the R.P.M. CONTROL HANDLE of a running engine is advanced rapidly, there may be insufficient torque pressure (approximately 50 p.s.i.) to open the low torque switch contacts before the auto-feathering circuit is completed. In this event the propeller will momentarily start to auto-feather (feathering pump warning light illuminated) until the torque pressure rises sufficiently, due to the increasing thrust transmitted by the coarsening propeller, to open the low torque switch contacts and break the auto-feathering circuit.

CAUTION: DO NOT OPEN THE THROTTLE TO RESTORE R.P.M. IF THE CONDITIONS SPECIFIED IN (g) OCCUR.

(f) Monitor the turbine gas temperature at all times when decelerating the engine, especially when the throttle is selecting r.p.m. below minimum constant speed (11,000 r.p.m.). Move the H.P.C. CONTROL lever to SHUT immediately, if under these conditions the turbine gas temperature increases and the r.p.m. reduces rapidly, without throttle movement, as this will indicate that the propeller is not reaching ground fine pitch.

(h) Only one R.P.M. CONTROL HANDLE at a time can be advanced to the full power position when the GUST LOCK lever is in the LOCK position.

B. Propeller system

(1) For all engine starting, the propeller must be on its ground fine pitch stop; this is indicated when the appropriate marks on the spinner and blades are aligned.

CAUTION: (1) 'THE FLIGHT FINE UNLOCKED' AND 'FLIGHT SAFE UNLOCKED' LIGHTS SHOULD BE ILLUMINATED DURING ALL GROUND RUNNING.

(2) FOR ALL GROUND RUNNING, POSITION THE HIGH PRESSURE FUEL VALVE CONTROL LEVER TO 'LOCK OUT' TO PREVENT (IN THE EVENT OF AN ELECTRICAL FAULT) ANY POSSIBILITY OF THE PROPELLER BEING RETAINED ON THE FLIGHT SAFETY PITCH STOP WHEN REDUCING ENGINE R.P.M.

(2) The GUST LOCK control handle must be at the LOCK position for all ground running to ensure that:

(a) Ground fine pitch is available, and that the electro-hydraulic stop is isolated for both propellers.

(b) The R.P.M. CONTROL HANDLE of both engines cannot be advanced together beyond taxying r.p.m. (a manual selector on the control pedestal allows either engine to be run at maximum r.p.m. provided the other engine R.P.M. CONTROL HANDLE is at IDLE.

C. Engine fire drill

WARNING: DO NOT RESTART THE ENGINE OR PLACE THE H.P.C. CONTROL HANDLE IN THE OPEN POSITION AFTER A FIRE WARNING UNTIL THE CAUSE OF THE FIRE WARNING HAS BEEN TRACED AND RECTIFIED.

(1) If the starter motor is running put the engine STARTER MASTER switch to SAFE.

(2) Feather the propeller of the affected engine.

(a) H.P.C. CONTROL HANDLE	Select FEATHER (this also shuts off fuel and water/methanol)
(b) FEATHERING button	PUSH until button remains in (2 secs. approx.)
(c) Fuel Shut off valve 'T' handle	Pull during feathering operation or as soon as possible after closing the H.P.C. CONTROL HANDLE

(3) When feathering drill is complete and if fire persists:

(a) Fire extinguisher switch	Select 'SHOT 1' first. If fire persists select 'SHOT 2'

NOTE: If the other engine is running, the propeller of this engine must also be feathered to facilitate ground fire fighting.

5. Fairchild and Fokker Friendship

A. Operating limitations

(1) R.P.M. and T.G.T.

(a) Dart 528-7E and 528D-7E

Condition	R.P.M.		Max. T.G.T. deg.C.	Time limit
During starts	-		930	Momentary
Static ground idling	Incidental		550	Unrestricted
TAKE-OFF With water/methanol Without water/methanol	 15,000 15,000		 860) 810)	5 minutes
MAX. CONTINUOUS	15,000		850	Unrestricted
Other conditions:	Below:	Not below:		
	15,000	14,000	785)	Unrestricted
	14,000	13,000	760)	
	13,000	10,400	730)	
	10,400	-	550)	
OVERSPEED	17,000 max.		-	20 seconds

NOTE: The ground idling r.p.m. at static sea-level conditions is determined by the fuel flow which, with the FUEL DATUM at full INCrease, is set to 31 plus or minus 1 Imp. gall/hr. (pre-Mod.1138 or 1394); 33.5 plus or minus 1 Imp. gall./hr. (Mod.1138 or 1394 but pre-Mod.1523) or 36 plus or minus 1 Imp. gall/hr. (Mod.1523). These fuel flows should give an idling r.p.m. between 6,500 and 7,500. Ambient conditions (including wind speed and direction) and variations in auxiliary gearbox loading will affect the r.p.m.

Power plant - Adjustment test (cont.)

(b) Dart 529-7E and 529D-7E

Condition	R.P.M.	Max. T.G.T. deg.C.	Time limit
During starts	-	930	Momentary
Static ground idling	Incidental	550	Unrestricted
TAKE-OFF With water/methanol Without Water/methanol	 15,000 15,000	 860) 825)	5 minutes
MAX. CONTINUOUS	15,000	850	Unrestricted
Other conditions:	Below: Not below:		Unrestricted
	15,000 14,000	785)	
	14,000 13,000	760)	
	13,000 10,400	730)	
	10,400 -	550)	
OVERSPEED	17,000 max.	-	20 seconds

NOTE: The ground idling r.p.m. at static sea-level conditions is determined by the fuel flow which, with the FUEL DATUM at full INCrease, is set to 31 plus or minus 1 Imp. gallons per hour (pre-Mod.1138 or 1394); 33.5 plus or minus 1 Imp. gallons per hour (Mod.1138 or 1394 but pre-Mod.1523) or 36 plus or minus 1 Imp. gallons per hour (Mod.1523). This fuel flow should give an idling r.p.m. between 6,500 and 7,500. Ambient conditions (including wind speed and direction) and variations in auxiliary gearbox loading will affect the r.p.m.

(c) Dart 529-7H and 529D-7H

Condition	R.P.M.	Max. T.G.T. deg.C.	Time limit
During starts	-	930	Momentary
Static ground idling	Incidental	550	Unrestricted
TAKE-OFF			
With water/methanol	15,000	860)	5 minutes
Without water/methanol	15,000	825)	
MAX. CONTINUOUS	15,000	850	Unrestricted
Other conditions:	Below: 15,000 Not below: 14,000	785)	Unrestricted
	Below: 14,000 Not below: 13,000	760)	
	Below: 13,000 Not below: 10,400	730)	
	Below: 10,400 Not below: -	550)	
OVERSPEED	17,000 max.	-	20 seconds

NOTE: The ground idling r.p.m. at static sea-level conditions is determined by the fuel flow which, with the FUEL DATUM at full INCrease, is set to 33.5 plus or minus 1 Imp. gall./hr. (Mod.1138 or 1394 but pre-Mod.1523) or 36 plus or minus 1 Imp. gall./hr. (Mod.1523). These fuel flows should give an idling r.p.m. between 6,500 and 7,500. Ambient conditions (including wind speed and direction) and variations in auxiliary gearbox loading will affect the r.p.m.

Power plant - Adjustment test (cont.)

(d) Dart 532-7

Condition	R.P.M.		Max. T.G.T. deg.C.	Time limit
During starts	-		930	Momentary
Static ground idling	Incidental		550	Unrestricted
TAKE-OFF				
With water/methanol	15,000		860)	5 minutes
Without water/methanol	15,000		810)	
MAX. CONTINUOUS	15,000		850	Unrestricted
Other conditions:	Below:	Not below:		
	15,000	14,000	785)	Unrestricted
	14,000	13,000	760)	
	13,000	10,400	730)	
	10,400	-	550)	
OVERSPEED	17,000 max.		-	20 seconds

NOTE: The ground idling r.p.m. at static sea-level conditions is determined by the fuel flow which, with the FUEL DATUM at full INCrease, is set to 33.5 plus or minus 1 Imp. gallons per hour (Mod.1138 or 1394 but pre-Mod.1523) or 36 plus or minus 1 Imp. gallons per hour (Mod.1523). This fuel flow should give an idling r.p.m. between 6,500 and 7,500. Ambient conditions (including wind speed and direction) and variations in auxiliary gearbox loading will affect the r.p.m.

(e) Dart 532-7L, 532-7N and 532-7R

Condition	R.P.M.		Max. T.G.T. deg.C.	Time limit
During starts	-		930	Momentary
Static ground idling	Incidental		550	Unrestricted
TAKE OFF				
With water/methanol	15,000		905)	5 minutes
Without water/methanol	15,000		810)	
MAX. CONTINUOUS	15,000		885	Unrestricted
Other conditions:	Below:	Not below:		
	15,000	14,000	785)	Unrestricted
	14,000	13,000	760)	
	13,000	10,400	730)	
	10,400	-	550)	
OVERSPEED	17,000 max.		-	20 seconds

NOTE: The ground idling r.p.m. at static sea-level conditions is determined by the fuel flow which, with the FUEL DATUM at full INCrease, is set to 33.5 plus or minus 1 Imp. gallons per hour (Mod.1138 or 1394 but pre-Mod.1523) or 36 plus or minus 1 Imp. gallons per hour (Mod.1523). This fuel flow should give an idling r.p.m. between 6,500 and 7,500. Ambient conditions (including wind speed and direction) and variations in auxiliary gearbox loading will affect the r.p.m.

(f) Dart 532-7P

Condition	R.P.M.		Max. T.G.T. deg.C.	Time limit
During starts	-		930	Momentary
Static ground idling	Incidental		550	Unrestricted
TAKE-OFF				
With water/methanol	15,000		925)	5 minutes
Without water/methanol	15,000		810)	
MAX. CONTINUOUS	15,000		910	Unrestricted
Other conditions:	Below:	Not below:		
	15,000	14,000	785)	Unrestricted
	14,000	13,000	760)	
	13,000	10,400	730)	
	10,400	-	550)	
OVERSPEED	17,000 max.		-	20 seconds

NOTE: The ground idling r.p.m. at static sea-level conditions is determined by the fuel flow which, with the FUEL DATUM at full INCrease, is set to 33.5 plus or minus 1 Imp. gallons per hour (Mod.1138 or 1394 but pre-Mod.1523) or 36 plus or minus 1 Imp. gallons per hour (Mod.1523). This fuel flow should give an idling r.p.m. between 6,500 and 7,500. Ambient conditions (including wind speed and direction) and variations in auxiliary gearbox loading will affect the r.p.m.

(g) Dart 536-7P

Condition	R.P.M.		Max. T.G.T. deg.C.	Time limit
During starts	-		930	Momentary
Static ground idling	Incidental		550	Unrestricted
TAKE-OFF With water/methanol Without water/methanol	 15,000 15,000		 940) 810)	5 minutes
INTERMEDIATE CONTINGENCY	15,000		935	Unrestricted
MAX. CONTINUOUS	15,000		810	Unrestricted
Other conditions:	Below:	Not below:		
	15,000	14,000	785)	Unrestricted
	14,000	13,000	760)	
	13,000	10,400	730)	
	10,400	-	550)	
OVERSPEED	17,000 max.		-	20 seconds

NOTE: The ground idling r.p.m. at static sea-level conditions is determined by the fuel flow which, with the FUEL DATUM at full INCrease, is set to 33.5 plus or minus 1 Imp. gallons per hour (Mod.1138 or 1394 but pre-Mod.1523) or 36 plus or minus 1 Imp. gallons per hour (Mod.1523). This fuel flow should give an idling r.p.m. between 6,500 and 7,500. Ambient conditions (including wind speed and direction) and variations in auxiliary gearbox loading will affect the r.p.m.

(h) Dart 536-7R

Condition	R.P.M.		Max. T.G.T. deg.C.	Time limit
During starts	-		930	Momentary
Static ground idling	Incidental		550	Unrestricted
TAKE OFF				
With water/methanol	15,000		905)	5 minutes
Without water/methanol	15,000		810)	
INTERMEDIATE CONTINGENCY	15,000		935	Unrestricted
MAX. CONTINUOUS	15,000		810	Unrestricted
Other conditions:	Below:	Not below:		Unrestricted
	15,000	14,000	785)	
	14,000	13,000	760)	
	13,000	10,400	730)	
	10,400	-	550)	
OVERSPEED	17,000 max.		-	20 seconds

NOTE: The ground idling r.p.m. at static sea-level conditions is determined by the fuel flow which, with the FUEL DATUM at full INCrease, is set to 33.5 plus or minus 1 Imp. gallons per hour (Mod.1138 or 1394 but pre-Mod.1523) or 36 plus or minus 1 Imp. gallons per hour (Mod.1523). This fuel flow should give an idling r.p.m. between 6,500 and 7,500. Ambient conditions (including wind speed and direction) and variations in auxiliary gearbox loading will affect the r.p.m.

Power plant - Adjustment/test (cont.)

B. Oil level, temperature and pressure.

(1) Oil level

(a) Ensure that the level of engine oil in the tank is not lower than 4 pints from full.

(2) Oil inlet temperature

(a) Maximum — plus 120 deg.C.

(b) Minimum for starting — minus 30 deg.C.

(c) Minimum for opening up — minus 15 deg.C.

NOTES: (1) If the oil temperature is below minus 30 deg.C. the engine must be pre-heated until the oil temperature is within limits before attempting to start the engine.

(2) If the oil temperature is below minus 15 deg.C., do not exceed Minimum constant speeding (11,000 r.p.m.) until a satisfactory oil temperature is obtained.

(3) Oil pressure

(a) Normal at 15,000 r.p.m. — 12 to 35 p.s.i.

(b) Minimum acceptable for flight at Maximum continuous r.p.m. — 12 p.s.i. at 120 deg.C.

(c) Minimum acceptable to complete a flight at any r.p.m. — 9 p.s.i.

CAUTION: STOP THE ENGINE IF THE LOW OIL PRESSURE WARNING LIGHT COMES ON AT OR ABOVE 11,000 R.P.M., OF IF THERE IS ANY ABNORMAL CHANGE IN OIL PRESSURE.

(4) Other limitations

(a) Refer to the Flight Manual or accessory manufacturers' manuals for any restrictions, other than those imposed by Rolls-Royce, which may affect ground running.

(5) Individual engine T.G.T. limitations (for control interconnections)

(a) In addition to the type ratings established for certification purposes and for use in flight, each engine has its individual maximum and minimum T.G.T. limits at Take-off and Maximum continuous conditions; these limits are determined by test bed performance and are listed on the engine Data plate.

(b) The Data plate TAKE-OFF T.G.T. limit at 15,000 r.p.m. and the F.C.U. rig-set idling fuel flow initially provide the basis for control interconnection and for performance ground checks.

(6) Excessive turbine gas temperature

(a) Any instance of the normal operating maximum turbine gas temperature being exceeded must be recorded in the engine log book, whether or not the engine is removed. The cause of the overheating must be fully investigated and action taken to prevent recurrence.

(b) If a defect occurs which will produce an overheat condition, the turbine gas temperature may rise rapidly. If it is apparent that the maximum T.G.T. will be exceeded, immediately move the H.P. cock lever to the OFF position. The engine need not be removed, provided the extent of overheat is within the following limits:

(i) Mk.532-7L, 532-7N, 532-7P, 532-7R and any mark of engine incorporating Mod.1258 or Mod.1581 H.P. turbine blades.

Temperatures up to 1000 degrees C. are permissible provided the duration in excess of the maximum wet or dry T.G.T., whichever is higher, at take-off r.p.m. does not exceed 5 seconds.

(ii) Any mark of engine not incorporating Mod.1258 or Mod.1581 H.P. turbine blades.

Temperatures up to 950 degrees C. are permissible provided the duration in excess of the maximum wet or dry T.G.T., whichever is higher at take-off r.p.m. does not exceed 5 seconds.

(iii) The limits specified in (a) and (b) do not apply to engine starting; during a start, the T.G.T. must not exceed 930 degrees C.

(c) If the above limits have been exceeded or whenever there is doubt as to the duration of overheating, record the details prevailing during the 'overheat', then remove the engine and return it for investigation.

(d) Experience has shown that auto coarsening, resulting in the propeller feathering fully does not usually damage the turbine assembly through overheating, even though the indicated T.G.T. exceeds the limitations provided that:

(i) The propeller moved right through to the fully feathered position without pause.

OR

(ii) The H.P. cock lever has been moved to the OFF position (when ground running) or to the feathered position (during take-off or in flight) before the T.G.T. has reached 1000 degrees C.

(iii) If the above conditions are not met, reject and return the engine to an overhaul base for investigation of suspected overheating.

PROPELLER SYSTEM FUNCTIONAL CHECKS (ENGINE STATIONARY)

1. General

A. Since correct functioning of the propeller is essential to the safe operation of the engine, carry out propeller checks before ground running the engine, after a propeller, engine or P.C.U. change, or after any disturbance to the propeller control system (electrical or mechanical), thereafter at the prescribed inspection periods.

B. Provided the propeller and feathering pump indicator lights are proved initially, they may be used as guides to propeller pitch changes during the remainder of the checks.

C. If the 'BELOW FINE LOCK' (Fairchild) or the 'PROP BELOW LOCK' (Fokker) warning light(s) fail(s) to illuminate or if the propeller fails to pass through the cruise pitch (flight safety) lock normally, rotate the propellers before investigating.

D. The FINE PITCH LOCK and CRUISE PITCH LOCK indicator lights (Fairchild) can only be proved by their 'press to test' facility when the corresponding test switch is held in the NEG FAULT position.

E. The 'FL. FINE LOCK' UNSAFE and the 'FL. SAF. UNLOCK' UNSAFE lights (Fokker) are designed to come on only when the corresponding lock withdrawal circuits are partially armed (see F.27 MAINTENANCE MANUAL for checking procedure).

F. During static functioning of the propeller, displaced oil from the propeller hub is discharged rapidly into the main pressure oil lines of the engine. With the engine stationary, this oil is not scavenged from the region of the main rotating assembly seals, nor will draining the sump clear it, but the possibility of oil flooding the engine will be avoided if the oil by-pass equipment GU.18829 or HW.68267/1 is used.

NOTE: If complete propeller checks are to be carried out fit oil by-pass equipment to both engines. If only part of the checks are to be effected and that part does not include auto-feathering, fit the equipment only to the subject engine.

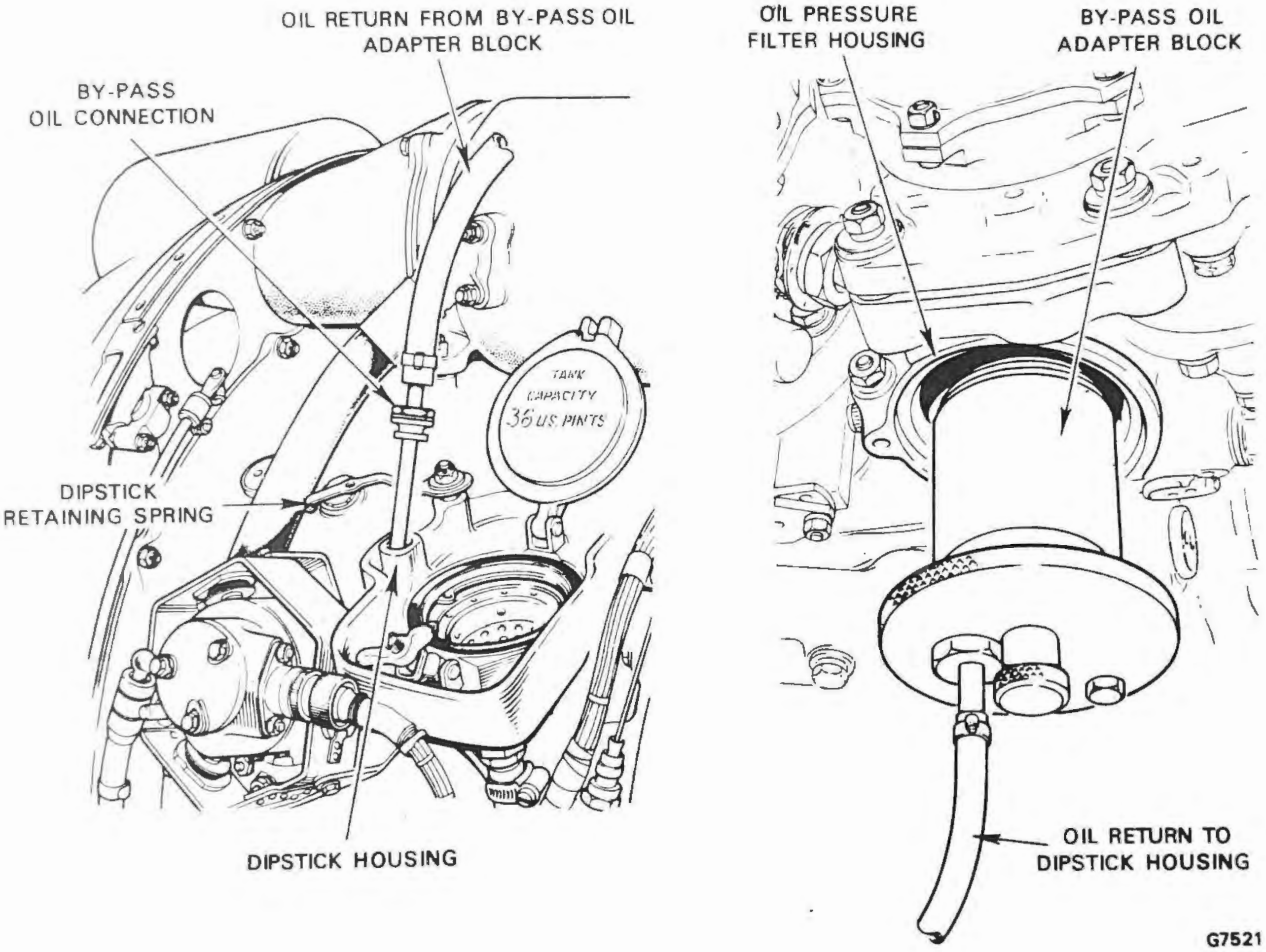
2. Fit the oil by-pass equipment

WARNING: THE SYNTHETIC LUBRICATING OIL USED IN THIS ENGINE CONTAINS ADDITIVES WHICH, IF ALLOWED TO CONTACT THE SKIN FOR PROLONGED PERIODS, CAN BE TOXIC THROUGH SKIN ABSORPTION.

Power plant - Adjustment/test (cont.)

CAUTION: (1) THE SYNTHETIC LUBRICATING OIL USED IN THE ENGINE MUST NOT BE MIXED WITH ANY OTHER OIL. IT IS INJURIOUS TO PAINTWORK AND CERTAIN TYPES OF RUBBER AND MUST NOT BE ALLOWED TO CONTACT ANY PART OF THE ENGINE OTHER THAN THE OIL SYSTEM. ANY OIL SPILT DURING SERVICING MUST BE WIPED UP IMMEDIATELY.

(2) COMPLETE BREAK-DOWN OF THE ENGINE SYNTHETIC OIL CAN BE CAUSED THROUGH CONTAMINATION BY CERTAIN ALKALINE CLEANING FLUIDS HAVING THE SAME APPEARANCE AS THE OIL, AND OF THE ORDER OF 0.05 PER CENT, THE AMOUNT THAT COULD CLING TO THE INSIDE OF AN APPARENTLY EMPTY CONTAINER. DO NOT USE ENGINE OIL CONTAINERS FOR ANY OTHER FLUID AND ENSURE THAT CONTAINERS AND EQUIPMENT ARE CLEAN BEFORE USING.


OIL RETURN FROM BY-PASS OIL ADAPTER BLOCK
BY-PASS OIL CONNECTION
TANK CAPACITY 36 US PINTS
DIPSTICK RETAINING SPRING
DIPSTICK HOUSING
OIL PRESSURE FILTER HOUSING
BY-PASS OIL ADAPTER BLOCK
OIL RETURN TO DIPSTICK HOUSING
G7521

Oil by-pass equipment
Fig.1

Power plant - Adjustment test (cont.)

A. Remove the pressure oil filter and by-pass valve assembly as instructed in Chapter 72-8 'OIL SYSTEM - MAINTENANCE PRACTICES'.

CAUTION: TO AVOID POSSIBLE CONTAMINATION OF THE ENGINE OIL SYSTEM, SCRUPULOUS ATTENTION TO CLEANLINESS MUST BE OBSERVED WHEN THE OIL BY-PASS EQUIPMENT IS USED.

B. Fit the oil by-pass equipment adapter block (Fig.1).

(1) Ensure that the sealing ring is located in the circumferential recess in the adapter block.

(2) Fit the adapter block into the pressure filter housing without dislodging the sealing ring; check that the dowel pin is correctly aligned with its locating hole in the housing.

(3) Finger tighten the captive retaining bolt.

C. Remove the dipstick from the engine oil tank (Fig.1).

D. Fit the by-pass equipment oil return pipe into the dipstick housing and secure it in position with the dipstick retaining spring (Fig.1).

3. Functionally check the propeller system

A. Ensure that the WATER METHANOL switch is OFF during all function checks of the propeller system. Failure to do so can result in inadvertent injection of water/methanol into the engine when the THROTTLE lever is opened.

B. Switch the FUEL BOOSTER PUMPS to OFF to minimize fuel leakage when the H.P. FUEL VALVE control lever is at OPEN or LOCK OUT (EMER OUT) during the propeller functional checks.

C. Effect the propeller checks in the manner and sequence detailed in para.5 'Propeller system functional checks' using Table 1A (Fairchild) or Table 1B (Fokker).

CAUTION: (1) DO NOT OPERATE THE FEATHERING PUMP MOTOR FOR LONGER THAN IS ESSENTIAL TO CONFIRM A CHECK AND IN ANY CASE DO NOT OPERATE IT FOR MORE THAN 3 MINUTES IN ANY ONE HOUR.

(2) SELECT 'EMER OUT' (LOCK OUT) ON THE HIGH PRESSURE FUEL VALVE CONTROL LEVER BEFORE ANY UNFEATHERING, OTHER THAN DETAILED IN TABLE 1A (FAIRCHILD) or 1B, (FOKKER) TO ENSURE THAT THE PROPELLER IS NOT HELD AT THE CRUISE LOCK (FLIGHT SAFETY LOCK) WITH CONSEQUENT FLOODING OF THE ENGINE OIL SYSTEM.

4. Remove the oil by-pass equipment

A. Observe the WARNING and CAUTIONS (topic 2.) then remove the by-pass equipment oil return pipe from the dipstick housing and allow it to drain.

B. Insert the dipstick in its housing and secure it with the dipstick retaining spring.

C. Remove the oil by-pass equipment adapter block from the pressure oil filter housing.

(1) Unscrew the adapter block captive retaining bolt.

(2) Position a suitable container under the pressure oil filter housing to collect surplus oil, then withdraw the adapter block from the filter housing.

D. Fit the oil pressure filter and by-pass valve assembly as instructed in Chapter 72-8 'OIL SYSTEM - MAINTENANCE PRACTICES'.

5. Propeller system functional checks; engine stationary.

A. Fairchild installation

TABLE 1A

ACTION	CHECK	RECTIFICATION
NOTE: For checking and rectification of the propeller, propeller electrical circuit and propeller control system refer to Chapter 61 - PROPELLER MAINTENANCE PRACTICES'.		
1. Preliminary (applicable to both left-hand (L.H.) and right-hand (R.H.) propeller systems). A. Ensure (1) Adequate oil supply available. (2) Oil by-pass equipment GU.18829 or HW.68267/1 fitted. (3) Ground electrical supply connected. (4) Both POWER CONTROL LEVERS at IDLING. (5) Both HIGH PRESSURE FUEL VALVE CONTROL LEVERS at CLOSED. (6) FLIGHT FINE PITCH LOCK EMERGENCY SWITCH to NORMAL. (7) GUST LOCK control handle at LOCK.		

TABLE 1A (cont.)

ACTION	CHECK	RECTIFICATION
1. Preliminary (cont.) (8) All relevant circuit breakers are activated and fuses fitted		
NOTE: (1) Where correct functioning of an electrical circuit is indicated by lights alone and rectification of the circuit is required before any of the following checks can be completed, check the indicator lights first to ensure that they are serviceable. (2) If the propeller is newly installed i.e., in the feathered position, move the appropriate H.P. COCK to FEATHER then hold the FEATHER PUMP switch at ON for 5 seconds to prime the propeller.		
	Both propellers on ground fine pitch stops (marks on spinners and blades aligned).	Move HIGH PRESSURE FUEL VALVE CONTROL LEVERS to EMER. OUT and PULL FEATHER buttons; release when propellers reach ground fine pitch stops and return HIGH PRESSURE FUEL VALVE CONTROL LEVERS to CLOSED.
	FLIGHT FINE UNLOCK light illuminated.	Rectify flight fine lock withdrawal circuit including gust lock control switches.
	Both BELOW FINE LOCK lights illuminated.	Rotate propellers; if defect persists rectify flight fine lock hub switch circuits, including appropriate contacts in auto-coarsening relays.

TABLE 1A (cont.)

ACTION	CHECK	RECTIFICATION
1. Preliminary (cont.)		
	Both CRUISE PITCH UNLOCK lights extinguished (oil pressure required to operate; press to test).	Change oil pressure operated switches on P.C.U. Refer to Fairchild Maintenance Manual.
B. Carry out the following checks:		
(1) Move FINE PITCH LOCK test switch to POS. FAULT and NEG. FAULT in turn.	Light illuminated in POS. FAULT position only.	Rectify test switch circuit.
(2) Move CRUISE PITCH LOCK test switch to POS. FAULT and NEG. FAULT in turn.	Light illuminated in both positions.	
(3) Select EMERGENCY on FINE PITCH LOCK emergency switch, then return to NORMAL.	FLIGHT FINE UNLOCK light is extinguished, then illuminates when switch is returned to NORMAL.	Rectify emergency switch.
(4) Move GUST LOCK control handle to UNLOCK.	FLIGHT FINE UNLOCK light remains illuminated.	Rectify lock withdrawal relays and or POWER CONTROL LEVER micro-switches (closed below 14,000 R.P.M.).

TABLE 1A (cont.)

ACTION	CHECK	RECTIFICATION
1. Preliminary (cont.)		
(5) Move pilot's R.H. POWER CONTROL LEVER fully forward.	FLIGHT FINE UNLOCK light is extinguished and warning buzzer sounds as POWER CONTROL LEVER is advanced beyond the 14,000 r.p.m. position.	Rectify R.H. POWER CONTROL LEVER micro-switch (opens above 14,000 r.p.m. and disarms flight fine pitch lock withdrawal circuit); rectify warning buzzer circuit, including buzzer relay, nose oleo switch and L.H. POWER CONTROL LEVER micro-switch (if R.H. feathering pump starts and propeller auto-coarsens rectify R.H. HIGH PRESSURE FUEL VALVE CONTROL LEVER auto-coarsening micro-switch).
(6) Move pilots R.H. POWER CONTROL LEVER to IDLING.	Warning buzzer continues to sound.	
(7) Move FINE PITCH LOCK test switch to NEG. FAULT.	FLIGHT FINE UNLOCK light remains extinguished.	Suspect R.H. lock withdrawal relay stuck in energized position.
(8) Lift and pull back pilots R.H. POWER CONTROL LEVER then release.	FLIGHT FINE UNLOCK light illuminates and warning buzzer ceases to sound as flight fine pitch lock withdrawal circuit is re-energized and remains so.	Rectify POWER CONTROL LEVER ground fine pitch switches or buzzer relay.

TABLE 1A (cont.)

ACTION		CHECK	RECTIFICATION
5. Unfeathering and cruise pitch lock check (cont.)			
L.H. PROPELLER SYSTEM	R.H. PROPELLER SYSTEM		
	(2) Pull feathering button and hold until propeller passes through cruise pitch lock.	R.H. propeller passes through cruise pitch lock (audible). CRUISE PITCH UNLOCK light may illuminate.	Suspect cruise pitch hub switch switch(es) not made; rotate propellers and re-check. If not O.K. rectify cruise pitch lock withdrawal circuit.
(3) Ensure HIGH PRESSURE FUEL VALVE CONTROL LEVER still open.			
(4) Pull feathering button and hold until propeller passes through cruise pitch lock.		L.H. propeller passes through cruise pitch lock (audible) and FEATHER PUMP ON light is illuminated. NOTE: The CRUISE PITCH UNLOCK light may come on while the feathering pump is running.	Rectify cruise pitch lock withdrawal circuit. or Change propeller lock unit; refer to Fairchild Maintenance Manual. or Change the P.C.U.; refer to Chapter 61-1, 'PROPELLER CONTROLLER UNIT - MAINTENANCE PRACTICES'.
(5) Return propeller to above cruise pitch lock.			

TABLE 1A (cont.)

ACTION	CHECK	RECTIFICATION
5. Unfeathering and cruise pitch lock check (cont.)		
H. Prove cruise pitch lock emergency switch effective.		
(1) Select EMERGENCY on cruise pitch lock emergency switch.		
L.H. PROPELLER SYSTEM R.H. PROPELLER SYSTEM		
(2) Move HIGH PRESSURE FUEL VALVE CONTROL LEVER to OPEN.		
(3) Pull feathering button and hold until propeller halted.	L.H. propeller fines off until it is held at the cruise pitch lock; (FEATHER PUMP warning light illuminated.	Rectify cruise pitch lock emergency switch.
J. Prove manual withdrawal of lock.		
(1) Move HIGH PRESSURE FUEL VALVE CONTROL LEVER to EMER. OUT.		

TABLE 1A (cont.)

ACTION	CHECK	RECTIFICATION
5. Unfeathering and cruise pitch lock check (cont.) L.H. PROPELLER SYSTEM R.H. PROPELLER SYSTEM (2) Pull feathering button and hold until propeller passes through the cruise pitch lock. (3) Select NORMAL on cruise pitch lock emergency switch.	L.H. propeller passes through the cruise pitch lock (audible; FEATHER PUMP ON light illuminated).	Check control static settings; if these are correct change the P.C.U.; refer to Chapter 61-1, 'PROPELLER CONTROLLER UNIT - MAINTENANCE PRACTICES'.
6. Flight fine pitch lock check. A. Ensure: (1) Flight fine unlock light extinguished (GUST LOCK still at UNLOCK). (2) Both POWER CONTROL LEVERS at IDLING. (3) Propeller is above flight fine pitch lock but below cruise pitch lock.		

TABLE 1A (cont.)

ACTION	CHECK	RECTIFICATION
6. Flight fine pitch lock check (cont.)		
(4) HIGH PRESSURE FUEL VALVE CONTROL LEVER at EMER. OUT.		
(5) IGNITION circuit breakers tripped.		
B. Pull feathering button and hold until propeller is halted.	Propeller fines off until held at flight fine pitch lock (FEATHER PUMP ON light illuminated).	If propeller passes through flight fine pitch lock check that withdrawal solenoids are energized. If not energized, change propeller lock unit; refer to Fairchild Maintenance Manual or Change P.C.U.; refer to Chapter 61-1, 'PROPELLER CONTROLLER UNIT - MAINTENANCE PRACTICES'.
C. Move GUST LOCK control handle to LOCK.	FLIGHT FINE UNLOCK light is illuminated.	Rectify GUST LOCK switches.
D. Move HIGH PRESSURE FUEL VALVE CONTROL LEVERS to OPEN.		

TABLE 1A (cont.)

ACTION	CHECK	RECTIFICATION
6. Flight fine pitch lock check (cont.)		
E. Pull feathering button and hold until propeller is halted.	Propeller passes through flight fine pitch lock (audible). Propeller fines off to ground fine pitch stop; (FEATHER PUMP ON light illuminated)	Move HIGH PRESSURE FUEL VALVE CONTROL LEVER to EMER. OUT and pull feathering button again. If the propeller now passes through the flight fine pitch lock, rectify cruise pitch lock withdrawal circuit (if not already checked as above). If the propeller is still held at flight fine pitch lock, rectify flight fine pitch lock withdrawal circuit. or Change the propeller lock unit; refer to Fairchild Maintenance Manual or Change the P.C.U.; refer to Chapter 61-1, 'PROPELLER CONTROLLER UNIT - MAINTENANCE PRACTICES'. Rotate propeller before investigating further.

TABLE 1A (cont.)

ACTION	CHECK	RECTIFICATION
6. Flight fine pitch lock check (cont.)		
F. With its HIGH PRESSURE FUEL VALVE CONTROL LEVER at OPEN, fine off other propeller to its ground fine pitch stop.	Propeller fines off to ground fine pitch stop. NOTE: The CRUISE PITCH UNLOCK light may illuminated while the feathering pump is running.	
G. Return both HIGH PRESSURE FUEL VALVE CONTROL LEVERS to CLOSED.		
H. Reset NOSE STEER PROP. BUZZER and IGNITION circuit breakers.		
7. Final checks.		
A. Ensure that the oil by-pass equipment has been removed and the oil pressure filter and dipstick refitted; refer to para.4.		
B. Ensure that the engine oil levels are correct. Refer to Chapter 72-8, 'OIL SYSTEM - MAINTENANCE PRACTICES'.		

TABLE 1B

5. Propeller system function checks; engine stationary (cont.)

B. Fokker installation

ACTION	CHECK	RECTIFICATION
NOTE: For checking and rectification of the propeller, propeller electrical circuit and propeller control system refer to Chapter 61 -'PROPELLER MAINTENANCE PRACTICES'.		
1. Preliminary (applicable to both left-hand (L.H.) and right-hand (R.H.) propeller systems)		
A. Ensure:		
(1) Adequate oil supply available.		
(2) Oil by-pass equipment GU.18829 or HW.68267/1 fitted.		
(3) Ground electrical supply connected.		
(4) Both R.P.M. CONTROL HANDLES closed to IDLE.		
(5) Both H.P.C. CONTROL HANDLES at SHUT.		
(6) FLT. SAFETY SWITCH at NORM.		
(7) ISOLAT. SW at NORM.		
(8) GUST LOCK control handle at LOCK		

TABLE 1B (cont.)

ACTION	CHECK	RECTIFICATION
1. Preliminary (cont.) (9) All relevant circuit breakers are activated and fuses fitted.		
NOTE: (1) Where correct functioning of an electrical circuit is indicated by lights alone and rectification of the circuit is required before any of the following checks can be completed, check the indicator lights first to ensure that they are serviceable. (2) If the propeller is newly installed i.e., in the feather position, move the appropriate H.P. COCK to FEATHER then hold the FEATHER PUMP switch at ON for 5 seconds to prime the propeller.		
	Propellers on ground fine pitch stops (marks on spinners and blades aligned).	Move H.P.C. CONTROL HANDLES to LOCK OUT and pull FEATHER buttons; release when propellers reach ground fine pitch stops and return H.P.C. CONTROL HANDLES to SHUT.
	Both PROP. BELOW LOCK lights are illuminated.	Rotate propellers; if defect persists, rectify flt. fine pitch lock hub switch circuits, including appropriate contacts in auto-coarsen relays.

TABLE 1B (cont.)

ACTION	CHECK	RECTIFICATION
1. Preliminary (cont.)		
	Both FLT. FINE UNLOCKED lights are illuminated.	Rectify flight fine pitch lock withdrawal circuit including GUST LOCK control switches.
	Both FLIGHT SAFE UNLOCKED lights are extinguished (Oil pressure required to operate; press to test).	Change oil pressure operated switches on P.C.U.
	FL. FINE LOCK UNSAFE light extinguished (press to test).	Rectify flight fine lock unsafe light circuit.
	FL. SAF. LOCK UNSAFE light extinguished (press to test).	Rectify flight safety lock withdrawal circuit, including unsafe warning light circuit.
B. Carry out the following checks:		
(1) Select ISOL. on isolating switch, then return to NORMAL.	Both FLIGHT FINE UNLOCKED lights are extinguished until isolating switch returned to normal.	Rectify flight fine isolating switch.
(2) Move GUST LOCK control handle to UNLOCK.	Both FLIGHT FINE UNLOCKED lights remain illuminated.	Rectify fine pitch relays and/or R.P.M. CONTROL HANDLE switches (closed below 14,000 r.p.m.).

TABLE 1B (cont.)

ACTION	CHECK	RECTIFICATION
1. Preliminary (cont.)		
(3) Move L.H. R.P.M. CONTROL HANDLE fully forward.	Both FLIGHT FINE UNLOCKED lights are extinguished and warning horn starts to blow as R.P.M. CONTROL HANDLE is advanced beyond the 14,000 r.p.m. position.	Rectify L.H. R.P.M. CONTROL HANDLE switch (should open above 14,000 r.p.m. and disarm flight fine lock withdrawal circuit); rectify warning horn circuit, including isolating relay and airspeed switch. If L.H. feathering pump starts and propeller auto-coarsens, rectify L.H. H.P.C. CONTROL HANDLE auto-coarsening micro-switch.
(4) Move R.H. R.P.M. CONTROL HANDLE fully forward.	Warning horn ceases to blow as R.P.M. CONTROL HANDLE passes the 14,000 r.p.m. position.	Rectify R.H. R.P.M. CONTROL HANDLE switch (should open above 14,000 r.p.m. and disarm flight fine lock withdrawal and warning horn circuits). If R.H. feathering pump starts and propeller auto-coarsens, rectify R.H. H.P.C. CONTROL HANDLE auto-coarsening micro-switch.
(5) Move R.H. R.P.M. CONTROL HANDLE to IDLE.	Warning horn starts to blow as R.P.M. CONTROL HANDLE is moved back past the 14,000 r.p.m. position FL. FINE LOCK UNSAFE light remains extinguished.	Suspect R.H. fine pitch relay stuck in energized position.
(6) Move L.H. R.P.M. CONTROL HANDLE to IDLE.	Warning horn continues to blow. FL. FINE LOCK UNSAFE light remains extinguished.	Suspect L.H. fine pitch relay stuck in energized position.

TABLE 1B (cont.)

ACTION	CHECK	RECTIFICATION
1. Preliminary (cont.)		
(7) Lift and pull back either or both R.P.M. CONTROL HANDLES, then release.	Both FLIGHT FINE UNLOCKED lights illuminate and horn ceases to blow as flight fine withdrawal circuit is re-energized and remains so.	Rectify R.P.M. CONTROL HANDLE ground fine pitch switches or warning horn isolating relay.
(8) Press each FEATHER button in turn.	Button stays in.	Rectify feather button hold in circuit.
	FEATHER PUMP warning light is illuminated.	Rectify manual feathering circuit.
	Feather pump starts.	If current is reaching feather motor terminals, change feather pump unit; refer to Chapter 61-2, 'FEATHERING PUMP - MAINTENANCE PRACTICES'.
	Propeller remains at ground fine pitch stop.	If propeller coarsening ceases at flight fine pitch lock angle, rectify the fine pitch relay contacts isolating the electro-hydraulic stop circuit. If propeller feathers fully, rectify control static settings; refer to Chapter 76-0, 'ENGINE CONTROLS - MAINTENANCE PRACTICES'.
	FLIGHT SAF. UNLOCKED light may be illuminated (operated by feather pump oil pressure).	Check later with engine running, if still no light, change P.C.U. switch; refer to Fokker Maintenance Manual.

TABLE 1B (cont.)

ACTION	CHECK	RECTIFICATION
1. Preliminary (cont.) (9) Pull out each FEATHER button on turn.	FEATHER PUMP warning light is extinguished and feather pump stops (FLIGHT SAF. UNLOCKED light is extinguished).	Trip manual feather circuit breaker and rectify feather button or feather pump relay.
2. Electro-hydraulic stop (pitch coarsening) check. A. Ensure GUST LOCK control handle at UNLOCK. Move R.H. R.P.M. CONTROL HANDLE fully forward (open).	Both FLIGHT FINE UNLOCKED lights are extinguished.	
B. Press FEATHER button of propeller being checked, hold until pitch coarsening confirmed, then pull button out.	Propeller pitch coarsens until flight fine pitch lock angle (approx.) is reached, and remains at or hunts around this angle. Feathering pump warning light illuminated. PROP. BELOW LOCK light extinguished or flashing. NOTE: FLIGHT SAFE UNLOCKED light may illuminate while the feather pump is running.	Rectify electro-hydraulic stop circuit, including appropriate fine pitch relay, or change P.C.U.; refer to Chapter 61-1, 'PROPELLER CONTROLLER UNIT - MAINTENANCE PRACTICES'.

TABLE 1B (cont.)

ACTION	CHECK	RECTIFICATION
3. Auto-coarsening (auto-feathering) checks for both L.H. and R.H. propeller systems. A. Ensure: (1) GUST LOCK control handle at UNLOCK. (2) Both propellers at flight fine pitch lock angle or above (PROP. BELOW LOCK lights out) but below fully feathered. (3) FLIGHT FINE LOCK WNG. circuit breaker tripped (to silence warning horn). NOTE: The FLIGHT SAFE UNLOCKED light may illuminate while the feather pump is running.		

TABLE 1B (cont.)

ACTION		CHECK	RECTIFICATION
3. Auto-coarsening (auto-feathering checks for both L.H. and R.H. propeller systems (cont.) B. Move the controls in the sequence numbered below:			
L.H. PROPELLER SYSTEM	R.H. PROPELLER SYSTEM		
(1) Ensure R.P.M. CONTROL HANDLE at IDLE.	(2) Ensure R.P.M. CONTROL HANDLE fully forward.		
	(3) H.P.C. CONTROL HANDLE to FEATHER.		
(4) H.P.C. CONTROL HANDLE to OPEN.			
(5) R.P.M. CONTROL HANDLE fully forward.		L.H. propeller does not auto-coarsen (feathering pump warning light remains extinguished) while R.H. H.P.C. CONTROL HANDLE is at FEATHER.	Rectify R.H. isolating relay or 'feather' circuit to it through R.H. H.P.C. CONTROL HANDLE micro-switch.

TABLE 1B (cont.)

ACTION		CHECK	RECTIFICATION
3. Auto-coarsening (auto-feathering) checks for both L.H. and R.H. propeller systems (cont.)			
L.H. PROPELLER SYSTEM	R.H. PROPELLER SYSTEM		
	(6) H.P.C. CONTROL HANDLE to SHUT.	L.H. propeller starts to auto-coarsen (feathering pump warning light illuminated).	Rectify L.H. propeller's auto-coarsening circuit including R.H. isolating relay and appropriate R.H. H.P.C. CONTROL HANDLE micro-switch; when rectified repeat auto-coarsening checks from commencement.
		L.H. PROP. BELOW LOCK light extinguished.	Rectify L.H. prop. below lock light circuit including appropriate contacts in L.H. auto-coarsen relay.
	(7) H.P.C. CONTROL HANDLE to OPEN as soon as L.H. propeller auto-coarsening confirmed.	L.H. propeller continues to auto-coarsen (feathering pump warning light illuminated) and	
		R.H. propeller does not auto-coarsen (feathering pump warning light remains extinguished) while L.H. propeller auto-coarsening is energized.	Rectify L.H. isolating relay or auto-coarsen circuit to it through L.H. H.P.C. CONTROL HANDLE micro-switch.

TABLE 1B (cont.)

ACTION	CHECK	RECTIFICATION
3. Auto-coarsening (auto-feathering) checks for both L.H. and R.H. propeller systems (cont.)		
L.H. PROPELLER SYSTEM R.H. PROPELLER SYSTEM		
(8) H.P.C. CONTROL HANDLE to SHUT as soon as non-auto-coarsening of R.H. propeller confirmed.	L.H. propeller stops auto-coarsening (feathering pump warning light is extinguished) and	Rectify L.H. H.P.C. CONTROL HANDLE auto-coarsening micro-switch.
	R.H. propeller now starts to auto-coarsen (feathering pump warning light illuminates).	Rectify R.H. propellers auto-coarsening circuit including L.H. isolating relay and appropriate L.H. H.P.C. CONTROL HANDLE micro-switch; when rectified repeat auto-coarsening checks from commencement.
	R.H. PROP. BELOW LOCK light extinguished.	Rectify R.H. prop. below lock light circuit, including appropriate contacts in R.H. auto-coarsen relay.
(9) H.P.C. CONTROL HANDLE to OPEN as soon as R.H. propeller auto-coarsening confirmed.	R.H. propeller continues to auto-coarsen (feathering pump warning light illuminates) and L.H. propeller does not re-start auto-coarsening (feathering pump warning light remains extinguished) while R.H. propeller auto-coarsening is energized.	Rectify 'auto-coarsen' circuit to R.H. isolating relay through R.H. H.P.C. CONTROL HANDLE micro-switch.

TABLE 1B (cont.)

ACTION		CHECK	RECTIFICATION
3. Auto-coarsening (auto-feathering) checks for both L.H. and R.H. propeller system (cont.)			
L.H. PROPELLER SYSTEM	R.H. PROPELLER SYSTEM		
(10) H.P.C. CONTROL HANDLE to FEATHER as soon as non-auto-coarsening of L.H. propeller confirmed.		R.H. propeller stops auto-coarsening (feathering pump warning light is extinguished)	Rectify 'feather' circuit to L.H. isolating relay through L.H. H.P.C. CONTROL HANDLE micro-switch.
(11) R.P.M. CONTROL HANDLE to IDLE.	(11) R.P.M. CONTROL HANDLE to IDLE.		
(12) H.P.C. CONTROL HANDLE to OPEN.		Neither propeller auto-coarsens (feathering pump warning light remains extinguished) with R.P.M. CONTROL HANDLES at IDLING.	Rectify R.P.M. CONTROL HANDLE switch(es) in auto-coarsening circuit(s).
(13) H.P.C. CONTROL HANDLE to SHUT.	(13) H.P.C. CONTROL HANDLE to SHUT.		
4. Manual feathering checks.			
A. Functional check			
(1) Ensure propeller is below fully feathered.			

TABLE 1B (cont.)

ACTION	CHECK	RECTIFICATION
4. Manual feathering checks (cont.)		
(2) Move H.P.C. CONTROL HANDLE to FEATHER.		
(3) Press feathering button for 2 seconds then release.	Propeller coarsens until fully feathered (feathering pump warning light illuminated).	Effect full installation feathering check; refer to para.B.
	Feathering button springs out when propeller fully feathered.	Pull out feathering button and change feathering cut-out switch on P.C.U.; refer to Fokker Maintenance Manual.
(4) Return H.P.C. CONTROL HANDLE to SHUT.		
B. Alternative installation check (Fokker S.B.61-26)		
(1) Ensure propeller is below fully feathered.		
(2) Disconnect H.P.C. control linkage at aircraft power plant firewall.		
(3) Position and hold P.C.U. feathering selector lever within 'UF' (unfeather) band markings.		

TABLE 1B (cont.)

ACTION	CHECK	RECTIFICATION
4. Manual feathering checks (cont.)		
(4) Move pilot's H.P.C. CONTROL HANDLE to FEATHER.		
(5) Press feathering button until propeller coarsening is confirmed, then pull out feathering button immediately.	Propeller starts to coarsen under electro-hydraulic FEATHER selection only; (FEATHER PUMP warning light is illuminated).	Rectify pilot's H.P.C. CONTROL HANDLE lever microswitch or circuit through auto-coarsen relay to pitch coarsening solenoid.
(6) Return pilot's H.P.C. CONTROL HANDLE to SHUT.		
(7) Position and hold P.C.U. feathering selector lever within the 'F' (feather) markings*		
* NOTE: With Mod.680 embodied, this can be effected by moving the H.P. cock pick-up lever on the control box to its Feather limit stop.		
(8) Press feathering button until propeller coarsening is confirmed, then pull out feathering button immediately.	Propeller re-starts coarsening under mechanical FEATHER selection only; (FEATHER PUMP warning light is illuminated).	Rectify control static settings; refer to Chapter 76-0, 'ENGINE CONTROLS - MAINTENANCE PRACTICES'. or Change the P.C.U.; refer to Chapter 61-1, 'PROPELLER CONTROLLER UNIT - MAINTENANCE PRACTICES'.

TABLE 1B (cont.)

ACTION	CHECK	RECTIFICATION
4. Manual feathering checks (cont.) (9) Reconnect H.P.C. control linkage at power plant firewall. (10) Verify appropriate control static checks and ensure security; refer to Chapter 76-0, 'ENGINE CONTROLS - MAINTENANCE PRACTICES'.		
5. Unfeathering and flight safety lock checks. NOTE: (1) These checks are detailed for checking the L.H. propeller system; to check R.H. propeller system read R.H. for L.H. (2) The FLIGHT SAFE UNLOCKED light may illuminate while the feathering pump is running. A. Ensure GUST LOCK control handle at UNLOCK. B. Both FLIGHT FINE UNLOCKED lights out.		

TABLE 1B (cont.)

Action		CHECK	RECTIFICATION
5. Unfeathering and flight safety lock checks (cont.)			
C. Both R.P.M. CONTROL HANDLES to IDLE.			
D. Pre-Mod.87: Trip ignition circuit breakers (to preclude possible operation of igniters when feathering button is pulled).			
E. Prove hub-switch at FEATHER.			
L.H. PROPELLER SYSTEM	R.H. PROPELLER SYSTEM		
(1) Ensure propeller fully feathered.	(2) Ensure propeller above flight safety lock.		
	(3) Move H.P.C. CONTROL HANDLE to OPEN.		
	(4) Pull feather button and hold until propeller passes through flight safety lock.	R.H. propeller passes through flight safety lock (audible) FLIGHT SAFE UNLOCKED light may illuminate.	Suspect L.H. propeller hub switch is not made when it is fully feathered rotate propellers and re-check. If not O.K. rectify flight safety lock withdrawal circuit.

TABLE 1B (cont.)

ACTION	CHECK	RECTIFICATION
5. Unfeathering and flight safety lock checks (cont.) L.H. PROPELLER SYSTEM — R.H. PROPELLER SYSTEM		
R.H. PROPELLER SYSTEM: (5) Return propeller to above flight safety lock (e.g. about 60 degrees).	FLIGHT SAFE UNLOCKED light extinguished.	
F. Prove unfeathering and flight safety lock effective.		
(1) Move H.P.C. CONTROL HANDLE to OPEN.		
(2) Pull FEATHER button and hold until propeller is halted, then release immediately.	Feathering pump warning light illuminates and pump motor operates until button is released.	Rectify feathering button unfeathering circuit.
	L.H. propeller unfeathers until it is held at the flight safety lock.	If L.H. propeller passes the flight safety lock, ensure withdrawal solenoids not energized. If not energized check the control static settings; refer to Chapter 76-0 - 'ENGINE CONTROLS - MAINTENANCE PRACTICES'. or Change the P.C.U.; refer to Chapter 61-1, 'PROPELLER CONTROLLER UNIT - MAINTENANCE PRACTICES'.

TABLE 1B (cont.)

ACTION		CHECK	RECTIFICATION
5. Unfeathering and flight safety lock checks (cont.)			
		L.H. FLIGHT SAFE UNLOCKED light is extinguished.	Change P.C.U. switch; refer to Chapter 61-1, 'PROPELLER CONTROLLER UNIT - MAINTENANCE PRACTICES'. or Suspect propeller third oil line drain blocked.
G. Prove normal electrical withdrawal of lock.			
L.H. PROPELLER SYSTEM	R.H. PROPELLER SYSTEM		
	(1) Move H.P.C. CONTROL HANDLE to OPEN.		
	(2) Pull FEATHER button until propeller passes through cruise lock.	R.H. propeller passes through the flight safety lock (audible). NOTE: The FLIGHT SAFE UNLOCKED light may come on while the feathering pump is running.	Rectify flight safety lock withdrawal circuit and/or defective hub switches; rotate both propellers then recheck, if not O.K. rectify circuit or hub switches as appropriate.
(3) Ensure H.P.C. CONTROL HANDLE still at OPEN.			

TABLE 1B (cont.)

ACTION		CHECK	RECTIFICATION
5. Unfeathering and flight safety lock check (cont.)			
L.H. PROPELLER SYSTEM	R.H. PROPELLER SYSTEM		
(4) Pull FEATHER button until propeller passes through the flight safety lock.		L.H. propeller passes through the flight safety lock (audible); (FEATHER PUMP warning light is illuminated) NOTE: The FLIGHT SAFE UNLOCKED light may illuminate while the feathering pump is running.	Rectify flight safety lock withdrawal circuit. or Change propeller lock unit; refer to Fokker Maintenance Manual or Change the P.C.U.; refer to Chapter 61-1, 'PROPELLER CONTROLLER UNIT - MAINTENANCE PRACTICES'.
(5) Return propeller to above the flight safety lock.			
H. Prove flight safety switch effective.			
L.H. PROPELLER SYSTEM	R.H. PROPELLER SYSTEM		
(1) Select EMERG. on FL. SAF. SWITCH.			
(2) Move H.P.C. CONTROL HANDLE to OPEN.			

TABLE 1B (cont.)

ACTION	CHECK	RECTIFICATION
5. Unfeathering and flight safety lock checks (cont.)		
L.H. PROPELLER SYSTEM R.H. PROPELLER SYSTEM		
(3) Pull FEATHER button and hold until propeller is halted.	L.H. propeller fines off until held at the flight safety lock; (FEATHER PUMP warning light is illuminated).	Rectify flight safety switch.
J. Prove manual withdrawal of lock.		
(1) Move H.P.C. CONTROL HANDLE to LOCK OUT.		
(2) Pull FEATHER button and hold until propeller passes through the flight safety lock.	L.H. propeller passes through the flight safety lock (audible); (FEATHER PUMP warning light is illuminated) NOTE: The FLIGHT SAFE UNLOCKED light may illuminate while the feathering pump is running.	Check control static settings; refer to Chapter 76-0, 'ENGINE CONTROLS - MAINTENANCE PRACTICES'. If control static settings are correct, change P.C.U.; refer to Chapter 61-1, 'PROPELLER CONTROLLER UNIT - MAINTENANCE PRACTICES'.
(3) Select NORMAL on FL. SAF. SWITCH.		

TABLE 1B (cont.)

ACTION	CHECK	RECTIFICATION
6. Flight fine pitch lock check.		
A. Ensure:		
(1) Both FLIGHT FINE UNLOCKED lights out (GUST LOCK CONTROL handle at UNLOCK).		
(2) Both R.P.M. CONTROL HANDLES at idle.		
(3) Propeller is above flight fine pitch lock but below flight safety lock.		
(4) H.P.C. CONTROL HANDLE at LOCK OUT.		
(5) IGNITION circuit breaker tripped (pre-Mod.87).		
B. Pull feather button and hold until propeller is halted.	Propeller fines off until it is held at flight pitch lock; (FEATHER PUMP warning light is illuminated) NOTE: The FLIGHT SAFE UNLOCKED light may illuminate while the feathering pump is running.	If propeller passes flight fine pitch lock, check that withdrawal solenoid is energized. If not energized, change the propeller lock unit; refer to Fokker Maintenance Manual. or Change P.C.U.; refer to Chapter 61-1, 'PROPELLER CONTROLLER UNIT - MAINTENANCE PRACTICES'.
C. Move GUST LOCK control handle to LOCK.	Both FLIGHT FINE UNLOCKED lights are illuminated.	Rectify GUST LOCK control switches.

TABLE 1B (cont.)

ACTION	CHECK	RECTIFICATION
6. Flight fine pitch lock check (cont.)		
D. Move H.P.C. CONTROL HANDLE to OPEN		
E. Pull FEATHER button until propeller is halted.	Propeller breaks through flight fine pitch lock (audible). (FEATHER PUMP warning light is illuminated). PROP. BELOW LOCK light is illuminated. NOTE: The FLIGHT SAFE UNLOCKED light may illuminate while the feathering pump is running. Propeller fines off to ground fine pitch stop.	Move H.P.C. CONTROL HANDLE to LOCK OUT and pull FEATHER button again. If propeller now passes through flight fine pitch lock, rectify flight safety lock withdrawal circuit (if not already checked, as above). If the propeller is still held at flight fine pitch lock, rectify flight fine pitch lock withdrawal circuit. or Change the propeller lock unit; refer to Fokker Maintenance Manual. or Change P.C.U.; refer to Chapter 61-1, 'PROPELLER CONTROLLER UNIT - MAINTENANCE PRACTICES'. Rotate propeller before investigating further.

TABLE 1B (cont.)

ACTION	CHECK	RECTIFICATION
6. Flight fine pitch lock check (cont.) F. With the H.P.C. CONTROL HANDLE at OPEN, fine off other propeller to its ground fine pitch stop.		
7. Final checks A. Move both H.P.C. CONTROL HANDLES to SHUT. B. Reset FLIGHT FINE LOCK WNG. circuit breaker (also IGNITION circuit breakers if applicable). C. Move GUST LOCK CONTROL HANDLE to LOCK. D. Ensure that the oil by-pass equipment has been removed and the oil pressure filter and dipstick refitted. Refer to para.4. E. Ensure that the engine oil levels are correct. Refer to Chapter 72-8, 'OIL SYSTEM - MAINTENANCE PRACTICES'.		

ENGINE STARTING, MOTORING AND STOPPING DRILL

1. Fairchild and Fokker Friendship

A. Preliminaries

WARNING: ENSURE THAT ALL PERSONNEL ARE KEPT CLEAR OF THE PROPELLER AND ENGINE EXHAUST GAS STREAMS.

NOTES: 1. The nomenclature of controls, switches, indicators and warning lights given in this publication is not necessarily compatible with that which will be given in the Aircraft Manufacturer's Flight Operations Manual.

2. The external and internal checks given in other Chapters of the Aircraft Maintenance Manual should be read in conjunction with this section prior to starting the engine.

(1) Position the aircraft, headed into wind, with adequate clearance from other aircraft and adjoining buildings; observe all local pre-start orders and fire precautions. Ensure that the area on which the aircraft stands is clear of all objects which could damage the engine/ propeller installation either by impact or through ingestion. If wintry conditions prevail, ensure all vents and intakes are clear of ice and snow.

CAUTION: DO NOT START OR RUN AN ENGINE WITHOUT A PROPELLER OR WITHOUT SUFFICIENT LUBRICATING OIL IN THE TANK. OIL LEVEL MUST NOT BE LOWER THAN 4 PINTS FROM FULL AS THIS WILL AFFECT TORQUE AND OIL PRESSURES.

(2) Rotate the propeller in each direction, if unusual noise or resistance to rotation is encountered the cause must be investigated and remedial action taken; refer to 'POWER PLANT - TROUBLE SHOOTING' (page block 101).

CAUTION: THE CHECK DETAILED IN PARAGRAPH (3) BELOW IS ESSENTIAL AS A LOW STARTER TERMINAL VOLTAGE CAN RESULT IN A HIGH T.G.T. DURING STARTING.

(3) Ensure that the ground starting equipment is in a serviceable condition and conforms to the requirements specified in Chap.89-11 'SPECIFICATION FOR ENGINE STARTING EQUIPMENT'.

Power plant - Adjustment/test (cont.)

B. External checks before starting

(1) Mainplanes and centre section	Leading edge and all panels secure
(2) Flying control surfaces	External locks removed (if fitted)
(3) Propellers	Security of spinner
(4) Engines	Covers and blanks removed
	Intakes and jet pipes clear
	Cowlings and panels secure
	H.E. igniter isolation switches ON
	Fire extinguisher pressure relief indicators intact
(5) Landing gear and wheels	Jury pins (ground locks) fitted
	Tyres correctly inflated
	Undercarriage oleo legs correctly charged
	Chocks in position (chocks staked if on grass)
(6) External power supply	Connected and ON; To avoid false (high) T.G.T. indications, position the external power unit so that the unit exhaust gases cannot be ingested by the running engine
(7) External intercom (if fitted)	Connected
(8) Doors, panels and refuelling caps	All secure

(9) Steps, trestles and any equipment not used during starting	Remove from vicinity of aircraft
(10) Fire fighting equipment	Correctly positioned

2. Fairchild Friendship

A. Crew compartment checks before starting (external power supply)

(1) BATTERY switches	OFF
(2) BUS switch	ON
(3) EXTERNAL POWER switch	ON (Check that voltage is 28 to 30 volts)
(4) INVERTER switch	ON
(5) GENERATOR TRIP switches	NORMAL
(6) GENERATOR control switch	OFF
(7) LOAD MONITOR switch	NORMAL
(8) PROP. BRAKE switch button (appropriate engine)	ON (PUSH)
(9) GUST LOCK	LOCK
(10) Fire warning test lights	Test by pressing the appropriate TEST switch (check lights illuminated)
(11) Engine synchronization switch	OFF
(12) PROP. FINE PITCH emergency switch	NORMAL
(13) PROP. CRUISE PITCH LOCK emergency switch	NORMAL

(14) BELOW FINE LOCK lights	Illuminated
(15) FL. FINE UNLOCK warning light	Illuminated
(16) FL. FINE circuit test switch (unsafe light)	POS. FAULT: light ON NEG. FAULT: light extinguished
(17) CRUISE PITCH UNLOCK light	Extinguished (oil pressure sensitive)
(18) CRUISE PITCH LOCK test	POS. FAULT: light ON NEG. FAULT: light ON
(19) FUEL HEATER switch	OFF (warning light extinguished)
(20) WATER METHANOL switch	OFF
(21) FUEL SHUT OFF valves	OPEN (control handle fully forward)
(22) FUEL TANK VALVE No.1 and No.2 switches	OPEN (warning light extinguished)
(23) FUEL CROSS FEED valve	OFF (closed)
(24) LOW OIL PRESSURE warning light	Illuminated

B. Crew compartment checks before starting (internal batteries)

(1) Effect the crew compartment checks detailed in A with the exception of the following:

(a) BATTERY switch	ON
(b) BUS switch	OFF
(c) EXTERNAL POWER switch	OFF
(d) INVERTER switch	OFF

C. Start the engine

CAUTION: (1) IF STARTER BUTTON DOES NOT REMAIN ENGAGED DURING STARTING (PRESS FOR 2 SEC. MAX.), WAIT UNTIL PROPELLER HAS CEASED ROTATING BEFORE MAKING A SECOND START ATTEMPT. DO NOT HOLD THE BUTTON IN.

(2) DO NOT INTERRUPT THE STARTING CYCLE UNTIL THE ENGINE HAS ACHIEVED A SATISFACTORY START (INDICATED BY AT LEAST 3,500 R.P.M. WITHOUT EXCESSIVE TURBINE GAS TEMPERATURE (T.G.T.)). IF THIS CONDITION IS NOT ACHIEVED MOVE THE HIGH PRESSURE FUEL VALVE CONTROL LEVER TO THE CLOSED POSITION AND MOVE STARTER MASTER SWITCH TO SAFE. IN ANY CIRCUMSTANCE THE STARTER BUTTON MUST NOT BE ALLOWED TO REMAIN IN FOR LONGER THAN 30 SECONDS (STARTER MOTOR LIMITATION).

(3) THE FUEL TRIM SETTING MUST NOT BE ALTERED DURING A SATISFACTORY START. ALLOW THE T.G.T. TO STABILIZE TO WITHIN ITS IDLING LIMITATION BEFORE TRIMMING FOR THE PREVAILING AMBIENT CONDITIONS.

(1) Before starting

(a) POWER LEVER	IDLING
(b) HIGH PRESSURE FUEL VALVE CONTROL lever	CLOSED
(c) PROPELLER	GROUND FINE PITCH: marks on spinner and blades aligned. If necessary to obtain alignment, move the HIGH PRESSURE FUEL VALVE CONTROL LEVER to EMER. OUT and PULL the feathering button until unfeathering is complete, then release the button and return the lever to CLOSED.

(d) FUEL DATUM indicator	50 per cent at O.A.T. of plus 15 degrees C. and above 100 per cent at O.A.T. below plus 15 degrees C.

NOTE: The fuel datum settings given are recommended for normal starting. If, in high ambient temperature conditions, hotter than normal starts are experienced it is permissible to attempt starts at a lower fuel datum setting. This practice is preferable to controlling turbine gas temperature with the high pressure fuel valve control lever during the starting cycle.

(e) FUEL BOOST PUMP switches (PORT or STBD as required)	ON; warning lights extinguished

(2) Starting

(a) Ground check	All clear for starting
(b) IGNITION TEST switch	OFF; warning light extinguished
(c) START SELECTOR switch	START
(d) START BUTTON for selected engine	Press for 2 seconds then release

NOTE: Under low ambient temperature conditions it may be necessary to advance the power lever slightly to assist light up. When light up has been achieved return the power lever to the idling position. As this practice could lead to high starting temperatures monitor the turbine gas temperature closely.

(3) During starting

NOTE: During a normal start, the engine will accelerate smoothly, the T.G.T. rising rapidly at first, then more slowly as 700 to 800 degrees C. are approached, finally falling within the idling limitations.

Power plant - Adjustment test (cont.)

(a) When engine speed reaches between 1200 r.p.m. and 1500 r.p.m.

(i) HIGH PRESSURE FUEL VALVE control lever	OPEN
(ii) BUS switch	ON
(iii) INVERTER switch	MAIN

CAUTION: IF THE OIL PRESSURE INDICATOR NEEDLE HAS NOT LEFT THE STOP, WHEN CHECKED AS INSTRUCTED IN (iv) BELOW, THE HIGH PRESSURE FUEL VALVE CONTROL LEVER MUST BE IMMEDIATELY SELECTED TO THE OFF POSITION, THE START SELECTOR SWITCH TO SAFE AND THE DEFECT RECTIFIED BEFORE A FURTHER START IS ATTEMPTED.

(iv) Oil pressure indicator	Check that needle has left stop (oil pressure stable or increasing but not fluctuating)

(b) If, during acceleration, engine r.p.m. falter at approximately 3,000, a partial light-up may be indicated. Provided that the maximum continuous T.G.T. has not been reached, move the power lever sharply forward approximately 1 inch, then back immediately to give an engine speed of not less than the minimum idling r.p.m. A starting fault is indicated if this practice has to be used.

CAUTION: EXERCISE GREAT CARE, WHEN USING THE FUEL METERING METHOD DETAILED IN (c) BELOW TO ENSURE THAT THE T.G.T. IS NOT ALLOWED TO EXCEED THE MAXIMUM LIMIT OF 930 DEGREES C.

(c) When it appears from the rate of rise of T.G.T. that 930 degrees C. will be exceeded, a shut down may be avoided by easing the high pressure fuel valve control lever towards the closed position to reducing the acceleration to idling r.p.m. A starting defect is indicated if it is necessary to use this procedure, and it must be adopted only in emergency or when investigating a defect.

(4) After starting

NOTE: If both engines are to be started repeat (1), (2) and (3) for the second engine before the following checks are carried out.

(a) When the engine has reached stabilized ground idling conditions check the following:

NOTE: A satisfactory check of idling can be made only after the engine has been warmed up, refer to ACTION G, in the relevant sub-section 4, in Section 4 - GROUND RUNNING PROCEDURE.

(i) FUEL DATUM indicator	Set according to ambient conditions (refer to Sub-section 4E - 'Charts')
(ii) Oil pressure indicator	Check OIL low pressure warning light OUT if oil pressure is above 5 to 6 p.s.i.
(iii) START SELECTOR switch	SAFE
(iv) HIGH PRESSURE FUEL VALVE control lever	EMER. OUT
(v) FLIGHT FINE UNLOCK warning light	Illuminated
(vi) MAX. T.G.T.	550 degrees C.
(vii) BATTERY switches	ON
(viii) EXTERNAL POWER switch	OFF
(ix) EXTERNAL POWER SUPPLY	Disconnected

D. Failure to achieve a satisfactory start

CAUTION: (1) IF AN ENGINE FAILS TO ACHIEVE A SATISFACTORY START, IMMEDIATELY MOVE THE HIGH PRESSURE FUEL VALVE CONTROL LEVER TO OFF AND PLACE THE START SELECTOR SWITCH TO SAFE. IF THE HIGH PRESSURE FUEL VALVE CONTROL LEVER HAS NOT BEEN CLOSED IMMEDIATELY AT THE CONCLUSION OF THE 30 SECONDS STARTING CYCLE, EFFECT A BLOW OUT CYCLE TO BLOW ACCUMULATED FUEL OUT OF THE ENGINE.

(2) AFTER THE SECOND CONSECUTIVE FAILURE TO START, CARRY OUT A BLOW OUT CYCLE, AS INSTRUCTED IN E BEFORE ATTEMPTING A FURTHER START.

(3) DO NOT MAKE A FURTHER ATTEMPT TO START UNTIL THE PROPELLER HAS COMPLETELY STOPPED ROTATING.

(4) TO PERMIT THE STARTER MOTOR TO COOL, ALLOW AN INTERVAL OF AT LEAST 15 MINUTES TO ELAPSE AFTER SIX CONSECUTIVE STARTING OR MOTORING CYCLES (INCLUDING ATTEMPTS TO START), WITH A NORMAL 'RUN-DOWN'.

(5) IF INTERNAL STARTING IS BEING CARRIED OUT NOT MORE THAN A TOTAL OF FOUR STARTS OR ATTEMPTS TO START MAY BE MADE.

(1) Indications

(a) Failure to light-up (no T.G.T.) within 20 seconds

(b) Failure of engine r.p.m. to increase above motoring speed (2,400 r.p.m. maximum) within 30 seconds.

(c) Excessive rise in T.G.T. whilst engine r.p.m. is increasing to idling speed.

E. Motor the engine (blow out cycle)

CAUTION: (1) TO PERMIT THE STARTER MOTOR TO COOL, ALLOW AN INTERVAL OF AT LEAST 15 MINUTES TO ELAPSE AFTER SIX CONSECUTIVE STARTING OR MOTORING CYCLES (INCLUDING ATTEMPTS TO START), WITH A NORMAL 'RUN-DOWN'.

(2) ONLY FOUR CONSECUTIVE MOTORING CYCLES ARE PERMITTED ON INTERNAL BATTERIES.

(1) Check that there is sufficient oil in the tank.

(2) Effect the starting procedure instructed in C. (including fuel booster pump switches ON) except for the following:

(a) HIGH PRESSURE FUEL VALVE CONTROL LEVER	CLOSE
(b) START MASTER switch	BLOW OUT; switch to SAFE after 30 seconds.
(c) Minimum engine r.p.m.	1800 r.p.m.

F. Stop the engine

WARNING: TO AVOID DANGER FROM POSSIBLE IGNITION OF RESIDUAL FUEL, PERSONNEL SHOULD KEEP WELL CLEAR OF THE ENGINE EXHAUST FOR AT LEAST 5 MINUTES AFTER THE SHUT DOWN.

(1) Proceed as follows:

(a) Engine synchronization switch	OFF
(b) WATER METHANOL switch	OFF
(c) FUEL DATUM indicator	Set as instructed in ACTION G. in the relevant sub-section in Section 4 - 'GROUND RUNNING PROCEDURE'.
(d) POWER LEVER	IDLING; allow engine speed to stabilize at idling conditions
(e) HIGH PRESSURE FUEL VALVE control lever	CLOSED
(f) FUEL SHUT OFF valve	CLOSED (control handle fully rearwards)
(g FUEL TANK No.1 and No.2 switches	CLOSED (warning light illuminated)
(h) FUEL CROSS FEED valve	OFF
(j) FUEL BOOST PUMP switches	OFF
(k) PROP. BRAKE switch (if fitted)	Apply at r.p.m. specified in FAIRCHILD MAINTENANCE MANUAL
(l) Propeller	Ground fine pitch position
(m) PROP FINE PITCH EMERGENCY switch	OFF
(n) POWER UNIT DE-ICING switch	OFF

(p) FUEL HEATER switch	OFF
(q) INVERTER switch	OFF
(r) BUS switch	OFF
(s) GENERATOR switch	OFF
(t) BATTERY switch	OFF

(2) If the aircraft is parked in the open check the following.

(a) Ensure that the propellers are secured to prevent rotation, otherwise windmilling could result in damage to the engine or injury to personnel.

(b) In cold weather, when icing conditions prevail, check that the oil cooler air ducts and matrix tubes, and the engine vents, are free of water or accumulations of snow, then fit approved covers and blanks to the oil cooler air ducts, engine air intake, exhaust unit and vents.

Power plant - Adjustment test (cont.)

3. Fokker Friendship

A. Crew compartment checks before starting (external or internal power supply)

NOTE: The minimum checks required before starting an engine are listed below. These checks need not be effected in the indicated sequence.

(1) BATTERY switch	
(a) External power supply	EXT. POWER (check voltage is 28 to 30 volts)
(b) Internal power supply	BATT.
(2) H.P.C. CONTROL HANDLE	SHUT
(3) WATER/METHANOL switch	OFF
(4) GUST LOCK lever	LOCK
(5) FLIGHT FINE ISOLATE switch	NORMAL
(6) FLT. SAFETY switch	NORMAL
(7) Propeller synchronizing	OFF
(8) PROPELLER BELOW LOCK lights	Illuminated
(9) FLIGHT FINE UNLOCK light	Illuminated
(10) FLIGHT FINE LOCK UNSAFE light	Extinguished
(11) FLIGHT SAF. UNLOCK lights	Extinguished (oil pressure sensitive)
(12) FLIGHT SAF. LOCK UNSAFE light	OFF
(13) Propeller parking brake (if fitted)	OFF
(14) INVERTER switch	ON
(15) GENERATOR switch	OFF

(16) Fire warning test light	Test by pressing appropriate TEST switch (check light comes on)
(17) EMERGENCY FUEL SHUT-OFF valves	OPEN (fully forward and secure)
(18) FUEL TANK ISOLATING VALVE switch	OPEN
(19) FUEL FILTER HEATER switch	OFF
(20) FUEL FILTER HEATER light	Extinguished
(21) IGNITION TEST switch	OFF (MOD.87) light extinguished NORMAL (PRE-MOD.87) light extinguished
(22) FUEL PRESSURE light	Extinguished
(23) OIL PRESSURE light	Illuminated
(24) OIL TEMPERATURE indicator	Above minus 30 degrees C.

B. Start the engine

CAUTION: (1) IF STARTER BUTTON DOES NOT REMAIN ENGAGED DURING STARTING (PRESS FOR 2 SEC. MAX.), WAIT UNTIL PROPELLER HAS CEASED ROTATING BEFORE MAKING A SECOND START ATTEMPT. DO NOT HOLD THE BUTTON IN.

(2) DO NOT INTERRUPT THE STARTING CYCLE UNTIL THE ENGINE HAS ACHIEVED A SATISFACTORY START (INDICATED BY AT LEAST 3,500 R.P.M. WITHOUT EXCESSIVE TURBINE GAS TEMPERATURE (T.G.T.)). IF THIS CONDITION IS NOT ACHIEVED MOVE THE H.P.C. CONTROL HANDLE TO THE CLOSED POSITION AND MOVE STARTER MASTER SWITCH TO SAFE. IN ANY CIRCUMSTANCE THE STARTER BUTTON MUST NOT BE ALLOWED TO REMAIN IN FOR LONGER THAN 30 SECONDS (STARTER MOTOR LIMITATION).

(3) THE FUEL TRIM SETTING MUST NOT BE ALTERED DURING A SATISFACTORY START. ALLOW THE T.G.T. TO STABILIZE TO WITHIN ITS IDLING LIMITATION BEFORE TRIMMING FOR THE PREVAILING AMBIENT CONDITIONS.

(1) Before starting

(a) R.P.M. CONTROL HANDLE	IDLE
(b) H.P.C. CONTROL HANDLE	SHUT
(c) Propeller	Ground fine pitch: The marks on spinner and blades should be aligned. If necessary align the marks by moving the H.P. FUEL COCK CONTROL lever to LOCK OUT and pulling the FEATHER button until the marks are aligned; release the FEATHER button and return the H.P. fuel cock control lever to CLOSED.
(d) FUEL DATUM indicator	Set: 50 per cent at outside air temperature of plus 15 degrees C. and above. 100 per cent at outside air temperature below plus 15 degrees C.

NOTE: The fuel datum settings given are recommended for normal starting. If, in high ambient temperature conditions, hotter than normal starts are experienced it is permissible to attempt starts at a lower fuel datum setting. This practice is preferable to controlling turbine gas temperature with the H.P. FUEL cock control LEVER.

(e) FUEL BOOSTER PUMP switches	ON

(2) Starting

(a) Ground check	All clear for starting
(b) STARTER MASTER switch	START
(c) ENGINE SELECTOR switch	PORT or STBD as required

(d) ENGINE START button	PRESS for 2 seconds then release

NOTE: Under low ambient temperature conditions it may be necessary to advance the r.p.m. control handle slightly to assist light-up. When light up has been achieved return the r.p.m. control handle to the idle position. As this practice could lead to high starting temperatures monitor the turbine gas temperature closely.

(3) During starting

NOTE: During a normal start, the engine will accelerate smoothly, the T.G.T. rising rapidly at first, then move slowly as 700 to 800 degrees C. are approached, finally falling within the idling limitations.

(a) When engine speed reaches between 1200 r.p.m. and 1500 r.p.m.

(i) H.P.C. CONTROL HANDLE	OPEN

CAUTION: IF THE OIL PRESSURE INDICATOR NEEDLE HAS NOT LEFT THE STOP, WHEN CHECKED AS INSTRUCTED IN (ii) BELOW, THE H.P.C. CONTROL HANDLE MUST BE IMMEDIATELY SELECTED TO THE CLOSED POSITION THE STARTER MASTER SWITCH TO SAFE AND THE DEFECT RECTIFIED BEFORE A FURTHER START IS ATTEMPTED.

(ii) Oil pressure indicator	Check that needle has left the stop (oil pressure stable or increasing but not fluctuating)

(b) If the r.p.m. falters at approximately 3000 r.p.m. during the acceleration, a partial light-up may have occurred. Provided that the T.G.T. has not reached the maximum limit, move the r.p.m. control handle sharply forward approximately 1 inch then back immediately to give an engine speed of not less than the minimum idling r.p.m. A starting fault is indicated if this practice has to be used.

CAUTION: EXERCISE GREAT CARE, WHEN USING THE FUEL METERING METHOD DETAILED IN (c) BELOW TO ENSURE THAT THE T.G.T. IS NOT ALLOWED TO EXCEED THE MAXIMUM LIMIT OF 930 DEGREES C.

(c) When it appears from the rate of rise of T.G.T. that 930 degrees C. will be exceeded, a shut down may be avoided by easing the H.P.C. control handle towards the closed position to reduce the fuel flow slightly and to maintain the T.G.T. within the limit without reducing the acceleration to idling r.p.m. A starting defect is indicated if it is necessary to use this procedure, and it must be adopted only in emergency or when investigating a defect.

(4) After starting

NOTE: If both engines are to be started repeat (1), (2) and (3) for the second engine before the following checks are carried out.

(d) When the engine has reached stabilized ground idling conditions check the following:

NOTE: A satisfactory check of idling can be made only after the engine has been warmed up, refer to ACTION G, in the relevant sub-section 4, in Section 4 - GROUND RUNNING PROCEDURE.

(i)	FUEL DATUM indicator	Set according to ambient conditions (refer to Sub-section 4E - 'Charts')
(ii)	Oil pressure indicator	Check OIL low pressure warning light OUT if oil pressure is above 5 to 6 p.s.i.
(iii)	H.P.C. CONTROL HANDLE	LOCK OUT
(iv)	STARTER MASTER switch	SAFE
(v)	GUST LOCK lever	LOCK
(vi)	FLIGHT FINE UNLOCK light	Illuminated
(vii)	FLIGHT SAF. UNLOCK light	Illuminated
(viii)	MAX.T.G.T.	550 degrees C.

(ix) GENERATOR switch ON

(x) BATTERY switch BATT.

C. Failure to achieve a satisfactory start

CAUTION: (1) IF AN ENGINE FAILS TO ACHIEVE A SATISFACTORY START, IMMEDIATELY MOVE THE H.P.C. CONTROL HANDLE TO CLOSED AND PLACE THE STARTER MASTER SWITCH TO SAFE. IF THE H.P.C. CONTROL HANDLE HAS NOT BEEN CLOSED IMMEDIATELY AT THE CONCLUSION OF THE 30 SECONDS STARTING CYCLE, EFFECT A BLOW OUT CYCLE TO BLOW ACCUMULATED FUEL OUT OF THE ENGINE.

(2) AFTER THE SECOND CONSECUTIVE FAILURE TO START, CARRY OUT A BLOW OUT CYCLE, AS INSTRUCTED IN D, BEFORE ATTEMPTING A FURTHER START.

(3) DO NOT MAKE A FURTHER ATTEMPT TO START UNTIL THE PROPELLER HAS COMPLETELY STOPPED ROTATING.

(4) TO PERMIT THE STARTER MOTOR TO COOL, ALLOW AN INTERVAL OF AT LEAST 15 MINUTES TO ELAPSE AFTER SIX CONSECUTIVE STARTING OR MOTORING CYCLES (INCLUDING ATTEMPTS TO START), WITH A NORMAL 'RUN-DOWN'.

(5) IF INTERNAL STARTING IS BEING CARRIED OUT NOT MORE THAN A TOTAL OF FOUR STARTS OR ATTEMPTS TO START MAY BE MADE.

(1) Indications

(a) Failure to light-up (no T.G.T.) within 20 seconds

(b) Failure of engine r.p.m. to increase above motoring speed (2,400 r.p.m. maximum) within 30 seconds.

(c) Excessive rise in T.G.T. whilst engine r.p.m. is increasing to idling speed

D. Motor the engine (blow out cycle)

CAUTION: (1) TO PERMIT THE STARTER MOTOR TO COOL, ALLOW AN INTERVAL OF AT LEAST 15 MINUTES TO ELAPSE AFTER SIX CONSECUTIVE STARTING OR MOTORING CYCLES (INCLUDING ATTEMPTS TO START), WITH A NORMAL 'RUN-DOWN'.

(2) ONLY FOUR CONSECUTIVE MOTORING CYCLES ARE PERMITTED ON INTERNAL BATTERIES.

(1) Check that there is sufficient oil in the tank.

(2) Effect the starting procedure instructed in B (including fuel booster pump ON) except for the following:

(a) H.P.C. CONTROL HANDLE	SHUT
(b) START MASTER switch	BLOW OUT; switch to SAFE after 30 seconds
(c) Minimum engine r.p.m.	1800 r.p.m.

E. Stop the engine

WARNING: TO AVOID DANGER FROM POSSIBLE IGNITION OF RESIDUAL FUEL, PERSONNEL SHOULD KEEP WELL CLEAR OF THE ENGINE EXHAUST FOR AT LEAST 5 MINUTES AFTER THE SHUT DOWN.

(1) Proceed as follows:

(a) Propeller synchronizer	OFF
(b) WATER/METHANOL switch	OFF
(c) FUEL DATUM indicator	Set as instructed in ACTION G., in the relevant sub-section in Section 4 - 'GROUND RUNNING PROCEDURE'.
(d) R.P.M. CONTROL HANDLE	IDLE; allow engine speed to stabilize at idling conditions
(e) H.P.C. CONTROL HANDLE	SHUT
(f) FUEL BOOSTER PUMP switch	OFF
(g) Propeller parking brake switch (if fitted)	Apply at the r.p.m. specified in F27 MAINTENANCE MANUAL
(h) Propeller	Ground fine pitch position
(j) POWER UNIT DE-ICING switch	OFF (light extinguished)

(k) FUEL FILTER HEATER switch	OFF
(l) EMERGENCY FUEL SHUT OFF valve	CLOSED (fully rearwards)
(m) FUEL TANK ISOLATING valve switch	CLOSED
(n) INVERTER switch	OFF
(p) GENERATOR switch	OFF
(q) STARTER MASTER switch	SAFE
(r) BATTERY switch	OFF

(2) If the aircraft is parked in the open:

(a) Ensure that the propellers are secured to prevent rotation, otherwise windmilling could result in damage to the engines or injury to personnel.

(b) In cold weather, when icing conditions prevail, check that the oil cooler air ducts and matrix tubes, and the engine vents, are free of water or accumulations of snow, then fit approved covers and blanks to the oil cooler air ducts, engine air intake, exhaust unit and vents.

ENGINE GROUND RUNNING PROCEDURES

1. General

A. Section 4 is divided into six Sub-sections separated by tabbed divider cards. This Sub-section explains the basic types of ground run and the occasions on which they are required, the preliminary checks necessary before ground running and the precautions to be taken prior to and during ground running. Additional information, to amplify that which is given for the particular checks called for is also included. The next four Sub-sections deal with specific types of ground run and are identified as follows:

Sub-section 4A - 'INSTALLATION GROUND RUN - DRY'

Sub-section 4B - 'GROUND RUN - WET'

Sub-section 4C - 'IN-SERVICE GROUND RUN - DRY'

Sub-section 4D - 'REMOVAL/RE-INSTALLATION GROUND RUN - DRY'

The remaining Sub-section 4E 'CHARTS', contains the ground running charts required to establish corrections for variations in pressure altitude and temperature.

B. Section 4 is divided, as detailed in A. to enable a ground engineer to extract the relevant Sub-section which,when used in conjunction with Sub-section 4E 'CHARTS', provides a complete set of instructions to effect the ground run.

C. Check lists are included in this section to enable the ground engineer to determine those checks that are essential in maintaining the serviceability requirements for engine ground running.

2. Engine operating indications

A. Engine indications

(1) Engine operation is indicated by the following:

R.p.m.
Turbine gas temperature
Torque pressure
Fuel flow

(a) R.p.m. and turbine gas temperature limits are specified to maintain the mechanical integrity while the power delivered is monitored by torque pressure.

(2) Each engine has its power level declared in terms of these parameters during the test bed running and this information is recorded in the engine log-book and on the Data-plate affixed to the engine.

(3) The engine controls are interconnected to the required power levels during the test bed run, but may need re-adjustment after installation in the aircraft. Since torque pressure can be influenced by an aircraft installation effect, datum torque pressure values are calculated and recorded during the installation ground run for in-service use. These values are known as:

Torque Pressure Upper Limit

Mintorque

and are valid only while the engine remains installed in the same position in the same aircraft. Removal and re-installation of an engine requires a re-declaration of these values; refer to Sub-section 4D 'REMOVAL/RE-INSTALLATION GROUND RUN - DRY'.

(4) In normal service operation, with fuel flow set to give Data-plate maximum temperature, the engine turbine gas temperature will gradually increase as power deterioration occurs. This should be allowed to continue until the turbine gas temperature reaches the Operating Limitation for Take-off, without water methanol, or the torque pressure falls below the 'Mintorque' limit. When this occurs, attempt to bring both these parameters within the acceptable limits by applying the procedures detailed in 'POWER PLANT - TROUBLE SHOOTING' (page block 101).

3. Precautions

A. Do not ground run an engine without a full understanding of engine handling and procedures detailed in this chapter.

B. Do not exceed the turbine gas temperature limits for the appropriate r.p.m.; refer to the crew compartment Data card.

C. Retain all data recorded while carrying out any power checks for subsequent reference, as this information may be required during trouble shooting or after a unit change.

D. Do not carry out engine power checks in ambient conditions in excess of I.S.A. + 35 degrees C.

4. Engine ground running

A. Use the minimum power commensurate with manufacturers' and/or operators' instructions.

B. At any condition where full power is not required (except IDLE) the fuel datum setting may be reduced to FULL DECREASE to conserve fuel.

C. Reset the fuel datum indicator for prevailing ambient conditions before closing the throttle to the idling r.p.m. position. When the throttle is in the closed position, reset the fuel datum position indicator as instructed in Action G. of the relevant Sub-section.

5. Engine r.p.m. checks

A. Because turbine gas temperature is affected by engine r.p.m. and consequent adjustments could critically affect engine power, it is important that engine r.p.m. is accurately checked.

B. When checking Take-off r.p.m., the oil inlet temperature should be between 65 and 75 degrees C. to ensure consistent results.

C. A satisfactory check of idling r.p.m. can only be carried out with the engine warm and at the correct fuel datum position.

6. Turbine gas temperature checks

A. During the installation ground run adjust the turbine gas temperature, if necessary, to within the Data-plate limits; refer to Sub-section 4A, 'INSTALLATION GROUND RUN - DRY'.

B. During engine life, as performance deteriorates the turbine gas temperature rises from the set value. Consequently, during the in-service ground run or removal/re-installation ground run, the turbine gas temperature is allowed to rise to the Operating Limitations turbine gas temperature; refer to Sub-sections 4C and 4D 'IN-SERVICE GROUND RUN - DRY' and 'REMOVAL/RE-INSTALLATION GROUND RUN - DRY'.

7. Engine power checks

A. On the installation ground run the corrected dry torque pressure, recorded with the engine running at the correct take-off r.p.m. and turbine gas temperature, is used to calculate the Mintorque and Torque Pressure Upper Limit. These reference torque pressures are used to monitor engine performance during subsequent power checks in service.

8. Mintorque and torque pressure upper limit

A. Mintorque is a calculated reference power check pressure based on the minimum guaranteed power T.G.T. declared during the test-bed run, and provides a datum torque pressure to check the minimum 'dry' power of the engine in service.

B. Experience has shown that at the conditions involved, each 1 degrees C. difference between the Data-plate maximum and minimum turbine gas temperature can be interpreted as 1 p.s.i. of torque pressure. Using this relationship, the mintorque is calculated as follows:

(1) A torque pressure value is obtained by subtracting the MIN. from the MAX. Data-plate turbine gas temperature and expressing the difference as p.s.i. Add 10 p.s.i. to this figure then, subtract the total from the corrected dry torque pressure. The resultant figure is used to declare the Mintorque at 70 and 100 degrees C. oil inlet temperature (O.I.T.).

C. Mintorque pressure should normally be obtained at a minimum oil inlet temperature of 85 degrees C. During extremely cold conditions, it is permissible to obtain the Mintorque at a temperature less than 85 degrees C. but not less than 70 degrees C., provided the engine has been run at Take-off conditions for at least 4 minutes.

D. All subsequent power checks should be carried out at, or as near as possible to, the oil inlet temperature at which the Mintorque was declared.

NOTE: On installed engines in service which have had a ground power check pressure (G.P.C.P.) declared, subtract 25 p.s.i. from the ground power check pressure to obtain the Mintorque value.

E. Torque pressure upper limit

(1) This dry torque pressure datum, which is calculated by the addition of 5 p.s.i. to the corrected dry torque pressure value, is declared at 70 and 100 degrees C. oil inlet temperature and is the maximum permissible dry torque pressure allowed when carrying out subsequent power checks.

F. Pilots minimum dry torque pressure

(1) The pilot has a different minimum dry torque pressure which takes into account the varying conditions encountered when a dry Take-off is being carried out. It is calculated by subtracting 25 p.s.i. from the Mintorque value declared at 70 degrees C. oil inlet temperature.

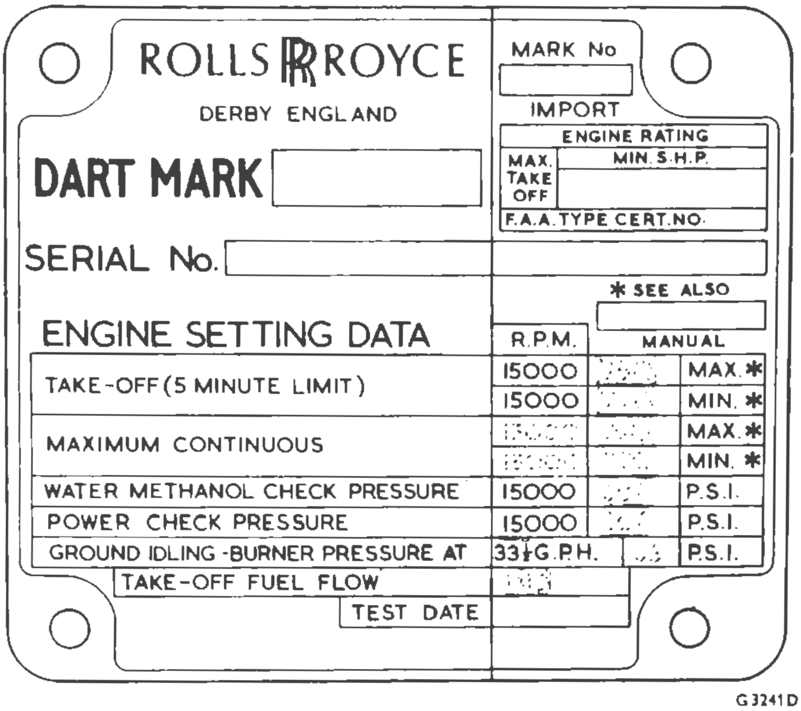
G. New reference torque pressures

(1) If an engine with an unexpired life is being removed and re-installed establish, prior to removal, a datum turbine gas temperature and a torque pressure margin above Mintorque for use when calculating the new reference torque pressures; refer to Sub-section 4D 'REMOVAL/RE-INSTALLATION GROUND RUN - DRY'.

Power plant - Adjustment test (cont.)

9. Engine Data-plate

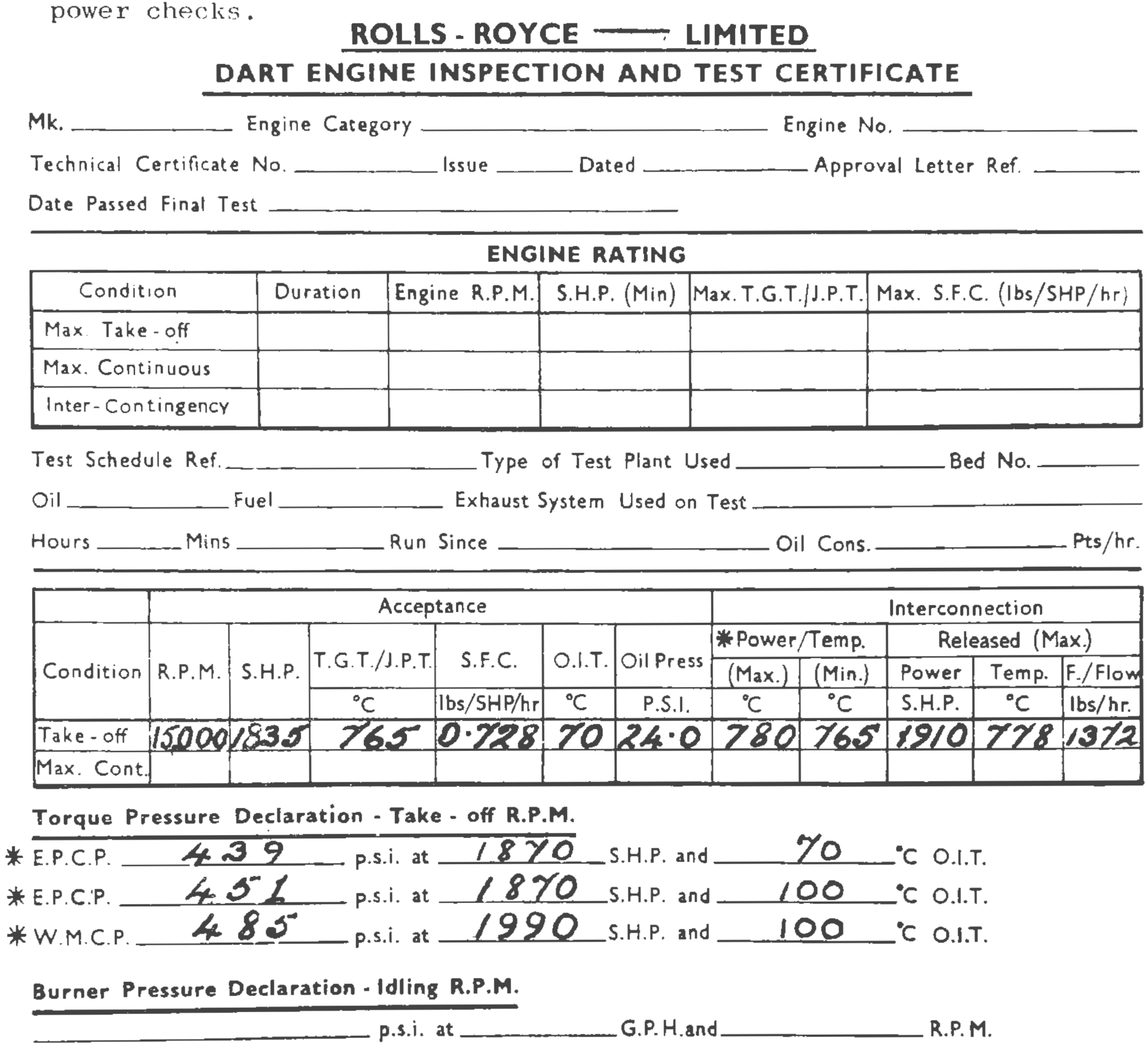
A. Fig.501 shows a typical Data-plate with the locations of the declared maximum r.p.m.,maximum and minimum turbine gas temperatures, water methanol check pressure and the power check pressure (E.P.C.P.) at 70 degrees C. oil inlet temperature.



Typical engine Data-plate
Fig.501

10. Engine inspection and test certificate

A. Fig.502 shows a typical engine inspection and test certificate. Items on the certificate marked thus * must be recorded before commencing engine power checks.



ROLLS - ROYCE —— LIMITED

DART ENGINE INSPECTION AND TEST CERTIFICATE

Mk. ________ Engine Category ________ Engine No. ________

Technical Certificate No. ________ Issue ________ Dated ________ Approval Letter Ref. ________

Date Passed Final Test ________

ENGINE RATING

Condition	Duration	Engine R.P.M.	S.H.P. (Min)	Max. T.G.T./J.P.T.	Max. S.F.C. (lbs/SHP/hr)
Max. Take-off					
Max. Continuous					
Inter-Contingency					

Test Schedule Ref. ________ Type of Test Plant Used ________ Bed No. ________

Oil ________ Fuel ________ Exhaust System Used on Test ________

Hours ________ Mins ________ Run Since ________ Oil Cons. ________ Pts/hr.

	Acceptance						Interconnection				
Condition	R.P.M.	S.H.P.	T.G.T./J.P.T.	S.F.C.	O.I.T.	Oil Press	✱Power/Temp.		Released (Max.)		
							(Max.)	(Min.)	Power	Temp.	F./Flow
			°C	lbs/SHP/hr	°C	P.S.I.	°C	°C	S.H.P.	°C	lbs/hr.
Take-off	15000	1835	765	0·728	70	24·0	780	765	1910	778	1372
Max. Cont.											

Torque Pressure Declaration - Take - off R.P.M.

✱ E.P.C.P. 439 p.s.i. at 1870 S.H.P. and 70 °C O.I.T.
✱ E.P.C.P. 451 p.s.i. at 1870 S.H.P. and 100 °C O.I.T.
✱ W.M.C.P. 485 p.s.i. at 1990 S.H.P. and 100 °C O.I.T.

Burner Pressure Declaration - Idling R.P.M.

________ p.s.i. at ________ G.P.H. and ________ R.P.M.

G 7464A

Typical engine inspection and test certificate
Fig.502

11. Oil level and pressure checks

A. Check that the level of engine oil in the tank is not lower than 4 pints from full.

B. The engine oil pressure warning light must be on when starting the engine and off when the oil pressure reaches 5 to 6 p.s.i.

C. Stop the engine if the oil pressure warning light is on at minimum constant speeding r.p.m. or above or, if there is any abnormal change in oil pressure.

D. When checking the oil pressure, ensure that the oil inlet temperature is above 55 degrees C. otherwise the pressure indication may be inaccurate due to pressure relief valve interference.

E. Check the oil pressure as instructed in the appropriate ground run.

12. Power unit ice protection system checks; refer to the appropriate ground run.

A. Make the check, irrespective of outside air temperature on each engine individually, with the engine running at not less than 12,800 r.p.m.

B. A system check is made by operating the individual engine switches and checking that the indicator lamp flashes fast or slow.

C. When a full system check is required operate the cyclic timer switch through one fast and one slow sequence. Observe the ammeter for indications of cycling of the elements.

13. Minimum constant speeding check

A. The minimum constant speeding r.p.m. is the engine speed at which the propeller control unit governor commences to control the engine r.p.m. and is the r.p.m. at which propeller pitch commences to coarsen off from ground fine pitch to absorb engine power. This check will establish whether the propeller control unit governor is set to control the engine r.p.m. at the correct datum.

14. Water/methanol system and wet power checks

A. The Data plate water/methanol check pressure is the torque pressure which represents the correct water/methanol 'wet' power at I.S.A. S.L. conditions. Where the pressure altitude varies from sea level, the appropriate altitude correction must be applied; refer to Sub-section 4B 'GROUND RUN - WET'.

B. 'Wet' power checks must not be carried out at oil inlet temperature below 70 degrees C.

C. The turbine gas temperature is not directly related to power when water/methanol is being used, however, do not exceed the appropriate maximum turbine gas temperature at Take-off with water/methanol.

15. Engine ground running check lists

A. The following check lists specify when ('OCCASION') an engine ground run is required, why ('BASIC REQUIREMENT') certain checks must be carried out and where ('GROUND RUN REFERENCE') the instructions for the particular ground run or check are located in this manual .

CAUTION: FAILURE TO CARRY OUT THE SPECIFIED GROUND RUN PROCEDURES WILL RESULT IN UNSATISFACTORY OPERATION OF THE ENGINE IN SERVICE.

ENGINE CHANGE AND IN-SERVICE CHECK

OCCASION	BASIC REQUIREMENT	GROUND RUN REFERENCE
A. After installation of a new, overhauled, partially overhauled or repaired engine (with zero hours since last test bed run).	(1) To check that the engine controls are interconnected to obtain the correct Take-off T.G.T. at the correct Take-off r.p.m. 'DRY' and 'WET'. (2) To check the fuel pump governor setting. (3) To establish the mintorque and the T.P.U.L. values for subsequent 'In-Service' use. (4) To check that water/methanol injection occurs and ceases at the correct r.p.m. (5) To check that the water/methanol control unit is set to the 'Data plate W.M.C.P.' value. (6) To check serviceability of the engine and associated systems.	REFER TO: Sub-section 4A 'INSTALLATION GROUND RUN - DRY'. Sub-section 4B 'GROUND RUN - WET'. Chapter 73-2 'FUEL PUMP - MAINTENANCE PRACTICES'. 3. Adjustment/test, para.A.
B. 'In-Service' ground run and power checks at recommended intervals.	(1) To check that the engine is within the 'In-Service' ground run limitations. (2) To check serviceability of the engine and associated systems.	REFER TO: Sub-section 4C 'IN-SERVICE GROUND RUN - DRY'. Sub-section 4B 'GROUND RUN - WET'.

Power plant - Adjustment/test (cont.)

ENGINE CHANGE AND IN-SERVICE CHECK (cont.)

OCCASION	BASIC REQUIREMENT	GROUND RUN REFERENCE
C. Before removal of a part-life engine.	(1) To establish serviceability of the engine for future use. (2) To establish the Datum T.G.T. (3) To establish the torque pressure margin above the mintorque value.	REFER TO: Sub-section 4D 'REMOVAL/RE-INSTALLATION GROUND RUN - DRY'. Run 1 (Removal run). NOTE: It is not necessary to carry out a ground run - wet, before removal of the engine.
D. After re-installation of a part-life engine (which has completed part of its life since last test bed run).	(1) To check that the engine controls are interconnected to obtain the Datum T.G.T. at the correct Take-off r.p.m. (2) To establish the new mintorque and the new T.P.U.L. values for subsequent 'In-Service' use. (3) To check that water/methanol injection occurs and ceases at the correct r.p.m. (4) To check that the water/methanol control unit is set to the 'Data plate W.M.C.P. value.' (5) To check serviceability of the engine and associated systems.	REFER TO: Sub-section 4D 'REMOVAL/RE-INSTALLATION GROUND RUN - DRY'. Run 2 (Re-Installation run). Sub-section 4B 'GROUND RUN - WET'.
E. As required during trouble shooting.	(1) To identify any reported fault and to confirm that rectification has been accomplished.	REFER TO: 'POWER PLANT - TROUBLE SHOOTING' (page block 101). Sub-section 4C 'IN-SERVICE GROUND RUN - DRY'. Sub-section 4B 'GROUND RUN - WET'.
F. After engine compressor cleaning.	(1) To check that the engine is within the 'In-Service' ground run limitations.	REFER TO: Chapter 72-3 'COMPRESSOR - MAINTENANCE PRACTICES' Para.2. Sub-section 4C 'IN-SERVICE GROUND RUN - DRY'.

ENGINE UNIT CHANGE

OCCASION	BASIC REQUIREMENT	GROUND RUN REFERENCE
A. After fuel pump change.	(1) To check that the fuel system operates satisfactorily. (2) To check the fuel pump governor setting. (3) To check that the engine is within the 'In-Service' ground run limitations.	REFER TO: Chapter 73-0 'ENGINE FUEL AND CONTROL - MAINTENANCE PRACTICES'. 1. Servicing, para.A. Aircraft Maintenance Manual, Chapter H 3. 'FUEL AND WATER METHANOL SYSTEMS - SERVICING AND MAINTENANCE', or 28-00 'FUEL SYSTEM - MAINTENANCE PRACTICES' and 28-20-00, 'FUEL DISTRIBUTION - MAINTENANCE PRACTICES' Chapter 73-2 'FUEL PUMP - MAINTENANCE PRACTICES'. 3. Adjustment/test, para.A. Sub-section 4C 'IN-SERVICE GROUND RUN - DRY'. ACTIONS A, B, D, G and H.
B. Before fuel control unit change.	(1) To establish the Datum T.G.T. prior to unit removal. CAUTION: IF THE FUEL CONTROL UNIT IS REJECTED DUE TO SUSPECTED METALLIC CONTAMINATION, DO NOT GROUND RUN THE ENGINE PRIOR TO REMOVAL OF THE FUEL CONTROL UNIT. (2) If the engine cannot be ground run prior to the fuel control unit change, use the results of the most recent ground run to establish the Datum T.G.T.	REFER TO: Sub-section 4D 'REMOVAL/RE-INSTALLATION GROUND RUN - DRY'. Run 1 (Removal run). ACTIONS A, B, D (T.G.T. only), G and H.
C. After fuel control unit change.	(1) To check that the fuel system operates satisfactorily after unit replacement. (2) To check that the engine controls are interconnected to obtain the datum T.G.T. at the correct Take-off r.p.m. (3) To check that the dry torque pressure is within the declared torque pressure limits. (4) To check serviceability of the engine and associated systems.	REFER TO: Chapter 73-0 'ENGINE FUEL AND CONTROL - MAINTENANCE PRACTICES'. 1. Servicing, para.A. Aircraft Maintenance Manual, Chapter H 3. 'FUEL AND WATER/METHANOL SYSTEMS - SERVICING AND MAINTENANCE', or 28-00 'FUEL SYSTEM - MAINTENANCE PRACTICES' and 28-20-00, 'FUEL DISTRIBUTION - MAINTENANCE PRACTICES'. Chapter 73-3 'FUEL CONTROL UNIT - MAINTENANCE PRACTICES'. 2. Adjustment/test.

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Power plant - Adjustment/test (cont.)

ENGINE UNIT CHANGE (cont.)

OCCASION	BASIC REQUIREMENT	GROUND RUN REFERENCE
D. After propeller control unit change.	(1) To check operation of the propeller system. (2) To check that the engine is controlled to the correct Take-off and Minimum Constant Speed r.p.m.	REFER TO: Section 2. 'PROPELLER SYSTEM FUNCTIONAL CHECKS'. Sub-section 4C 'IN-SERVICE GROUND RUN - DRY'. ACTIONS A, B, D, F, G and H.
E. After propeller change.	(1) To check operation of the propeller. (2) To check operation of the engine and propeller control systems.	REFER TO: Section 2 'PROPELLER SYSTEM FUNCTIONAL CHECKS'. Sub-section 4C 'IN-SERVICE GROUND RUN - DRY' ACTIONS A, B, D, E, F, G and H.
F. After water/methanol control unit change.	(1) To check that water/methanol injection occurs and ceases at the correct r.p.m. (2) To set the water/methanol control unit to the Data-plate W.M.C.P. value.	REFER TO: Sub-section 4B 'GROUND RUN - WET'. Chapter 82-00-1, 'WATER/METHANOL CONTROL UNIT - MAINTENANCE PRACTICES'
G. After hot air valve (fuel heater) and/or solenoid change.	(1) To function check the hot air valve.	REFER TO: Sub-section 4C 'IN-SERVICE GROUND RUN - DRY' ACTIONS A, B, C, G and H.
H. After oil cooler change.	(1) To check that the engine oil pressure system is serviceable and within the 'In-Service' ground run limitations.	REFER TO: Sub-section 4C 'IN-SERVICE GROUND RUN - DRY' ACTIONS A, B, E, G and H.
J. After starter motor change.	(1) To function check the starter motor.	REFER TO: Section 3. 'ENGINE STARTING, MOTORING and STOPPING DRILLS', para.7.

ENGINE COMPONENT CHANGE

OCCASION	BASIC REQUIREMENT	GROUND RUN REFERENCE
A. After combustion chamber assemblies and/or flame tube changes.	(1) To check the Take-off T.G.T. and adjust, if necessary, to within the 'In-Service' ground run limitations.	REFER TO: Chapter 72-5 'COMBUSTION SECTION - MAINTENANCE PRACTICES'. 4. Adjustment/test, para.A.
B. After discharge nozzle change	(1) To check that the engine is serviceable and is within the 'In-Service' ground run limitations.	REFER TO: Sub-section 4C 'IN-SERVICE GROUND RUN - DRY' ACTIONS A, B, D, G and H.
C. After thermocouples and or harness change.	(1) To check that the Take-off T.G.T. is within the 'In-Service' ground run limitations.	REFER TO: Chapter 77-2-1 'THERMOCOUPLES AND HARNESS - MAINTENANCE PRACTICES'. 2.Adjustment/test. Sub-section 4C 'IN-SERVICE GROUND RUN - DRY'. ACTIONS A, B, D (T.G.T. only), G and H
D. After oil pressure relief valve change.	(1) To check that the engine oil pressure system is serviceable and within the 'In-Service' ground run limitations.	REFER TO: Sub-section 4C 'IN-SERVICE GROUND RUN - DRY'. ACTIONS A, B, E, G and H.
E. After propeller shaft seal change.	(1) To check operation of the propeller. (2) To check operation of the engine and propeller control systems.	REFER TO: Section 2 'PROPELLER SYSTEM FUNCTIONAL CHECKS'. Sub-section 4C 'IN-SERVICE GROUND RUN - DRY'. ACTIONS A, B, D, E, F, G and H.

MISCELLANEOUS

OCCASION	BASIC REQUIREMENT	GROUND RUN REFERENCE
A. After disturbance of any part of the engine fuel system, other than the fuel pump and the fuel control unit.	(1) To check that the engine fuel system operates satisfactorily.	REFER TO: Chapter 73-0 'ENGINE FUEL AND CONTROL - MAINTENANCE PRACTICES'. 1. Servicing, para.A. Aircraft Maintenance Manual, Chapter H 3. 'FUEL AND WATER METHANOL SYSTEMS - SERVICING AND MAINTENANCE', or 28-00, 'FUEL SYSTEM - MAINTENANCE PRACTICES' and 28-20-00, 'FUEL DISTRIBUTION - MAINTENANCE PRACTICES' Sub-section 4C 'IN-SERVICE GROUND RUN - DRY'.
B. After disturbance of any part of the engine oil system, other than the oil cooler and the oil pressure relief valve.	(1) To check that the engine oil pressure system is serviceable and within the 'In-Service' ground run limitations.	REFER TO: Sub-section 4C 'IN-SERVICE GROUND RUN - DRY'. ACTIONS A, B, E G and H. Chapter 72-8 'OIL SYSTEM - MAINTENANCE PRACTICES'.
C. After engine control cross-shaft maintenance and/or controls adjustment.	(1) To check that the engine is within the 'In-Service' ground run limitations. (2) To check that water/methanol injection occurs and ceases at the correct r.p.m. (3) To check that the 'W.M.C.P.' is within acceptance limits.	REFER TO: Sub-section 4C 'IN-SERVICE GROUND RUN - DRY'. Sub-section 4B 'GROUND RUN - WET'.

INSTALLATION GROUND RUN - DRY

1. Object of ground run

   A. To interconnect the engine controls so that at the correct Take-off r.p.m. the engine will run at the correct turbine gas temperature (T.G.T.).

   B. To establish the Mintorque value; this is an installed torque pressure which is used as a datum to check minimum dry power in service.

   C. To establish the torque pressure upper limit (T.P.U.L.) value; this is an installed torque pressure which determines the maximum dry torque pressure allowed in service.

   D. To establish the pilot's minimum dry torque pressure.

   E. To check that all engine systems are acceptable for service.

2. Action required before commencing installation ground run

   A. Instrumentation and pyrometry

      (1) Ensure that the r.p.m. gauge is accurately calibrated.

      (2) Ensure that the T.G.T. gauge is accurately calibrated; refer to Chap.77, 'ENGINE INDICATING'.

   B. Check the engine r.p.m. and cross-check the aircraft r.p.m. gauge as follows:

      (1) Fit the cannon connector on the connecting lead E.R.E.2382 to the r.p.m. 'IN' socket on the front of the r.p.m. digital indicator, E.R.E.2380, refer to Fig.502A.

      (2) Remove the electrical plug from the r.p.m. gauge, fitted to the aircraft cockpit instrument panel and connect the plug to the aircraft gauge plug (female) on the connecting lead E.R.E.2382.

      (3) Fit the aircraft gauge harness plug (male) to the r.p.m. gauge fitted to the aircraft cockpit instrument panel.

(4) Move the digital indicator switch to 'ON'.

NOTE: The 'Normal' indicator light will illuminate if the indicator battery has an adequate charge.

(5) The indicator is ready for immediate use, but the measuring accuracy will be improved by approximately 0.1 per cent if the indicator is allowed to warm up for 30 minutes.

(6) If the 10 per cent charge indicator light illuminates the indicator can be used for a short period, but it, will require to be re-charged before further prolonged use; refer to Appendix 2.

NOTE: A full charge will allow approximately 8 hours use.

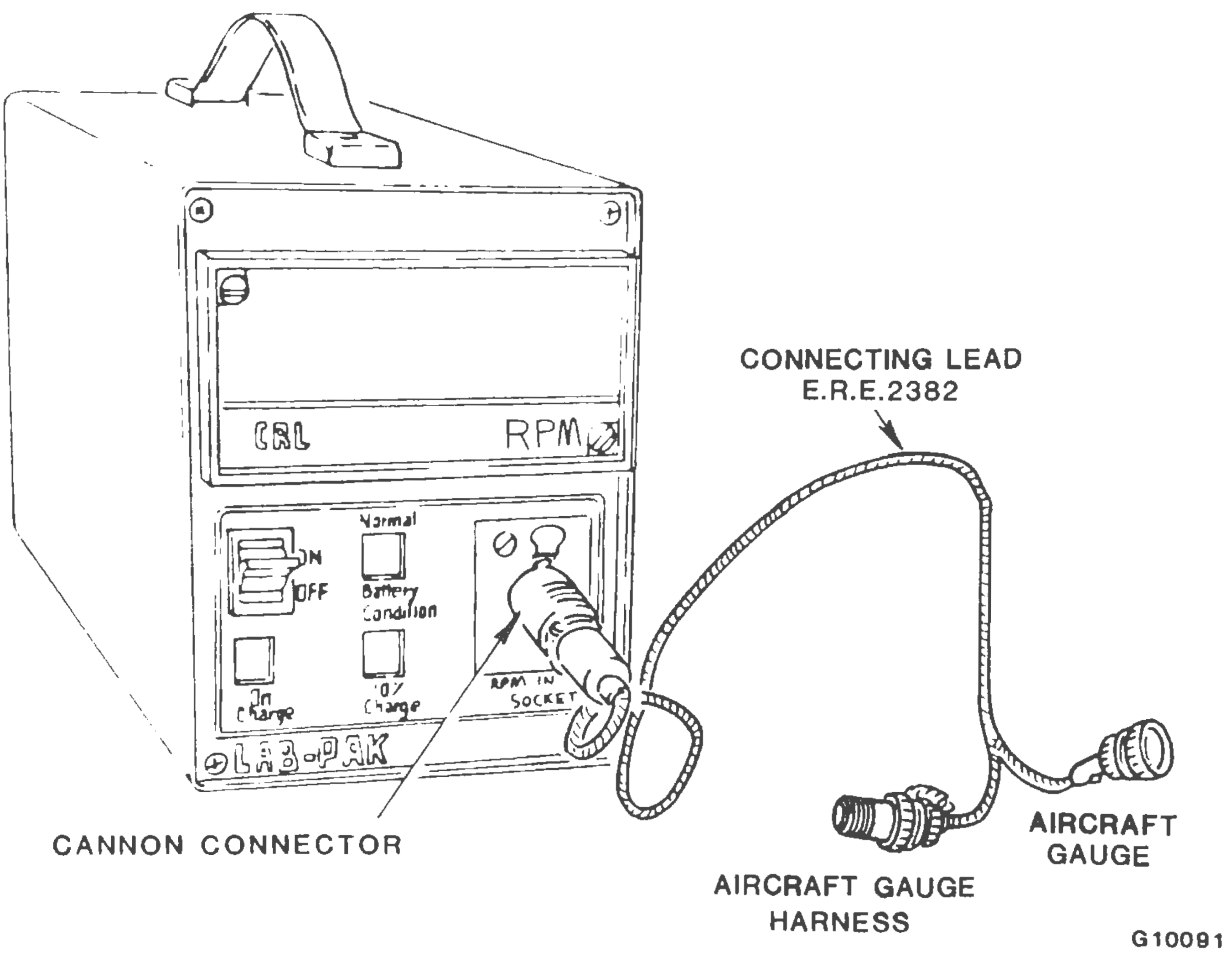
(7) On satisfactory completion of the checks effect the following:

(a) Move the digital indicator switch to 'OFF'.

(b) Disconnect the 2 plugs on the connecting lead, E.R.E.2382, from the aircraft harness lead and the r.p.m. gauge.

(c) Connect the aircraft harness electrical plug to the r.p.m. gauge.

(d) If required, remove the cannon connector from the 'IN' socket of the r.p.m. digital indicator.



R.p.m. digital indicator
Fig.502A

Power plant - Adjustment/test (cont.)

C. Check the engine T.G.T. and cross-check the aircraft T.G.T. gauge as follows:

(1) Pre-Mod.1792 engines

(a) Remove the engine thermocouples main junction box cover.

(b) Pass one end of the 2 metres (6.6 ft.) Chromel/Alumel cable, GZ.39165 or GZ.39165/2, through the aperture of the slave cover, GZ.39166 for pre-Mod.1567 engines or GZ.39167 for Mod.1567 engines.

(c) Fit the brown insulated Chromel lead of the cable under the washers on the setscrew (pre-Mod.1567) or the 4 B.A. nut on the extended setscrew (Mod.1567) which secures the red insulated harness leads to the terminal adjacent to the aircraft extension lead opening in the main junction box. Leave the harness and the aircraft extension leads connected.

(d) Fit the blue insulated Alumel lead of the cable under the washers on the setscrew (pre-Mod.1567) or the 4 B.A. nut on the extended setscrew (Mod.1567) which secures the blue insulated harness leads to the other terminal in the main junction box. Leave the harness and the aircraft extension leads connected.

(e) Fit the slave cover to the main junction box.

(2) Mod.1792 engines

(a) Remove the dust cap from the socket on the aluminium body, mounted on the engine thermocouples main junction box, then connect the 2 metres (6.6 ft.) (Chromel/Alumel cable and plug, GZ.39164 or GZ.39164/2, to the socket.

(3) Using the terminal block, connect the 27 metres (88.6 ft.) Copper/Constantan cable, ERE.2347, to the 2 metres (6.6 ft.) Chromel/Alumel cable, GZ.39165 (pre-Mod.1792) or cable and plug, GZ.39164 (Mod.1792); refer to Fig.502B.

(a) Using the socket supplied with GZ.39164/2 and GZ.39165/2 connect the 27 metres (88.6 ft.) Copper/Constantan cable ERE.2347, to the 2 metres (6.6 ft.) Chromel/Alumel cable GZ.39165/2 (pre-Mod. 1792) or cable and plug GZ.39164/2 (Mod.1792) refer to Fig.502C.

(4) Connect the other end of the Copper/Constantan cable, ERE.2347, to the terminal posts of potentiometer R.R. type GZ.38989 or Foster tye 3154/1883, 3155/DP2163, 3156/DP2163 as follows:

(a) Connect the white insulated copper lead of the cable to the red terminal post of the potentiometer.

(c) Connect the blue insulated constantan lead of the cable to the black terminal post of the potentiometer.

NOTES: (1) The length of the Copper/Constantan cable can be reduced to suit operators requirements.

(2) When using R.R. potentiometer type GZ.38989, the leads can be connected to either set 1 or set 2 terminal posts.

(3) Potentiometers other than those detailed in para.(4) can be used provided they comply with the following:-

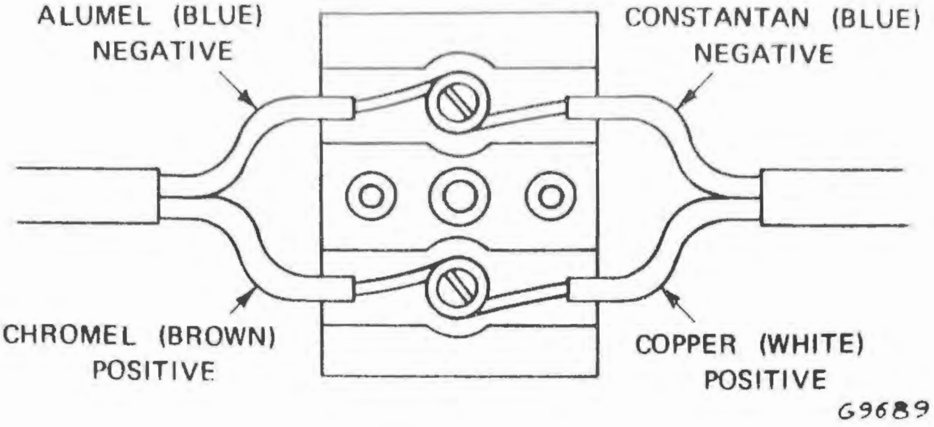
(a) Scale range 0-1000 deg.C. Nickel Chromium/Nickel Aluminium BS.4937, Type K.

(b) Available millivolt source (60 mV) for calibration of 8 or 25 ohms T.G.T. indicators.

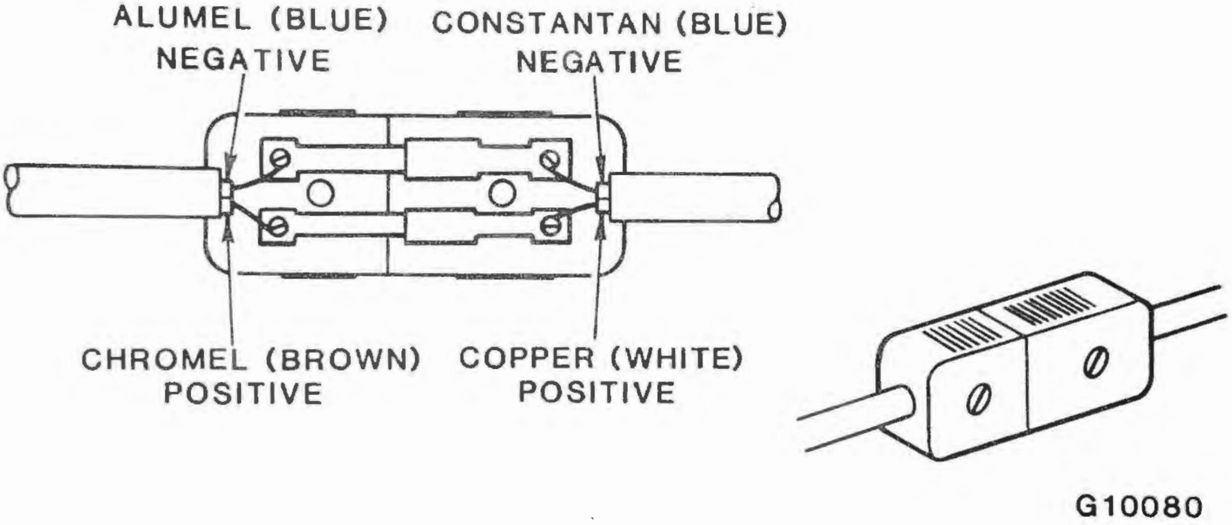
(c) Automatic or manual cold junction temperature compensation.

(d) Instrument accuracy of ± 0.2 per cent of span maximum.

Power plant - Adjustment/test (cont.)



(GZ.39164 and GZ.39165)
Cable leads connected to terminal block
Fig.502B



(GZ.39164/2 and GZ.39165/2)
Cable leads connected to plug assembly
Fig.502C

(c) Position the potentiometer in the place where it will be operated and allow approximately 15 minutes for the carcase temperature to stabilize before taking any readings.

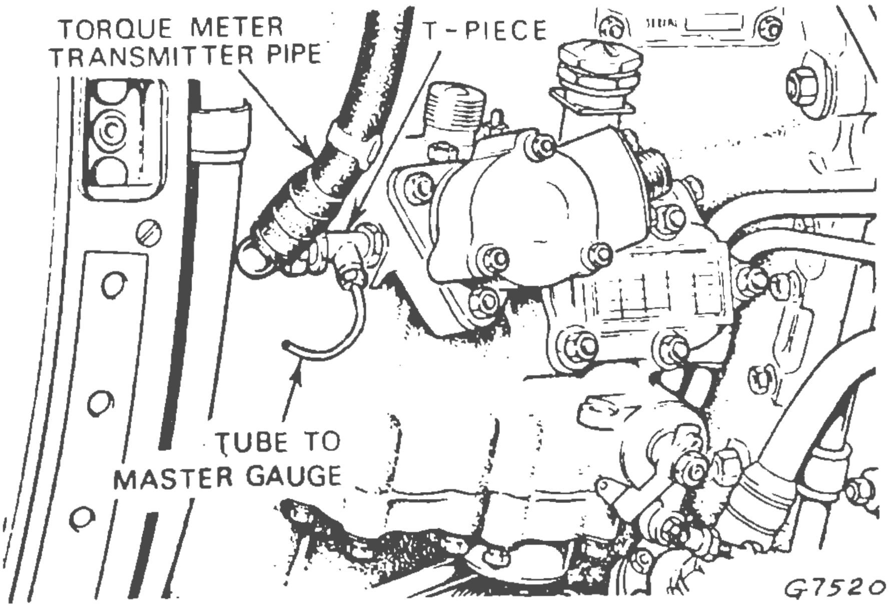
(d) Ensure that the range cap is securely connected on the 60 M.V. socket, and that the potential divider switch is OFF. When using R.R. type GZ.38989, select 60 M.V. on the M.V. switch (situated on the bottom right side of the instrument panel) by moving the switch to the right.

(e) Zero the galvanometer, with button K1 pressed, by rotating the standardising rheostat knob (clockwise moves the needle to the right). On R.R. type GZ.38989 ensure that the galvanometer switch is not in the off position, then push the lever of the MEASURE/STANDARDISE switch to STANDARDISE and zero the galvanometer using the standardising rheostat knob (clockwise moves the needle to the right). If any difficulty is experienced in stabilizing or adjusting the needle, renew the batteries.

(f) Obtain the potentiometer terminal temperature from the mercury thermometer attached to the carcase of the potentiometer, then set this temperature on the cold junction scale (C.J. scale, black numerals).

(g) Set the main temperature scale (0 - 1400 degrees C., black numerals) to approximately the required T.G.T. (this will avoid damage to the galvanometer by excessive deflections when the T.G.T. readings are taken during the ground run).

NOTE: Refer to ACTION 4.D. for the method of operation of the Foster Potentiometer when checking the T.G.T. at maximum take-off conditions.



T-piece adapter - water/methanol control unit
Fig.503

Power plant - Adjustment/test (cont.)

(5) Connect a Bourdon tube type master pressure gauge (GZ.36755/1) between the torquemeter pressure transmitter oil pipe and the connection on the water/methanol control unit, using a T-piece adapter and a suitable length of tubing; refer to Fig.503.

(6) Alternatively, when using torquemeter pressure digital indicator, ERE.2317, connect T-piece adapter, GZ.39107, between the torquemeter transmitter oil pipe and the connection on the water/methanol control unit, then connect transducer, ERE.2320, to the T-piece adapter ensuring that the sealing washer is fitted between the adapter and transducer; refer to Fig.A and Fig.B.

NOTE: The Dowty sealing washer is supplied with the transducer.

(a) Connect the 6 pin Bendix connector on the coupling cable, ERE.2348 to the transducer, then route the cable carefully to the aircraft cockpit and connect the 5 pin Cannon connector on the cable to the socket on the front panel of the digital indicator.

(b) Move the digital indicator switch to 'ON'.

NOTE: The 'Normal' indicator light will illuminate if the indicator battery has adequate charge.

(c) The indicator is ready for immediate use, but measuring accuracy will be improved by approximately 0.1 per cent if the indicator is allowed to warm up for 30 minutes.

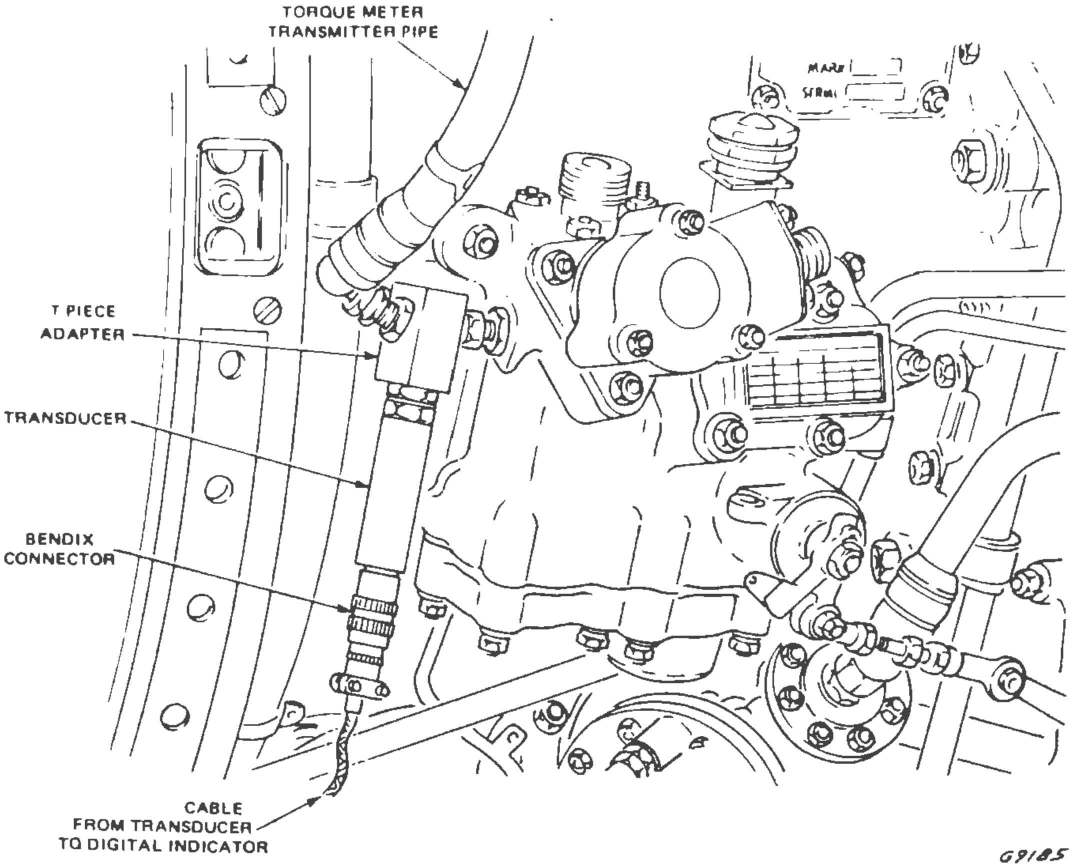
(d) If the '10% Charge' indicator light illuminates the indicator can be used for a short period, but it will require to be re-charged before further prolonged use; refer to Appendix 1, para.3.

NOTE: A full charge will allow approximately 8 hours use.

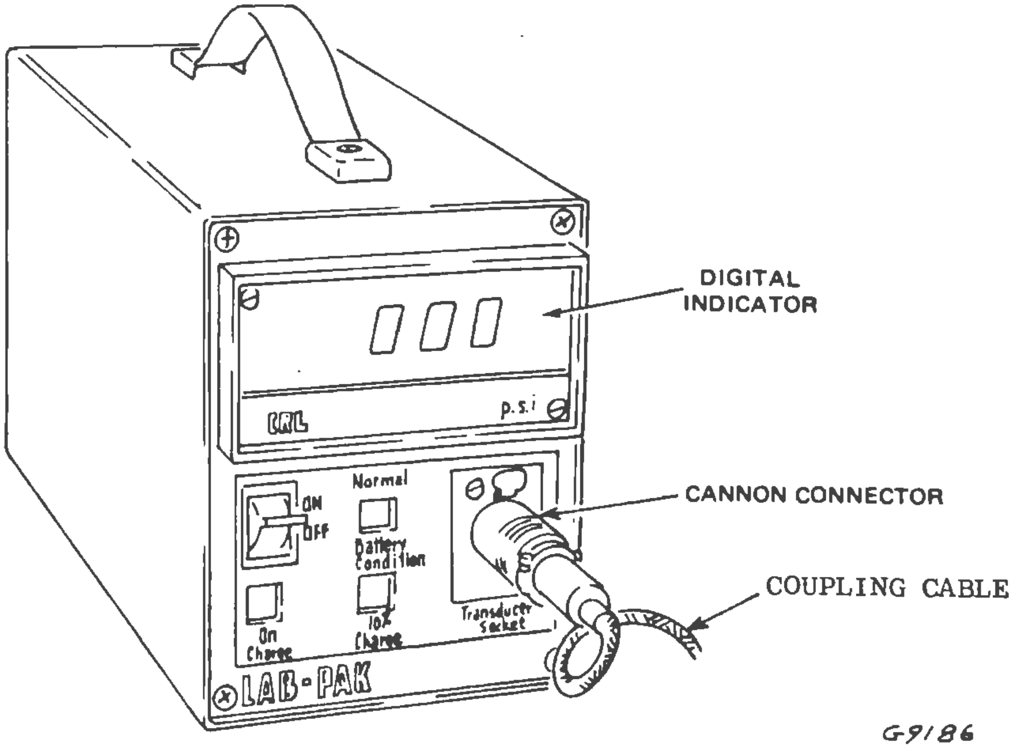
(e) The transducer and digital indicator should be used together as a matched set. If either the transducer or digital indicator have to be replaced (because of a fault) the instrument set should be re-calibrated before further use; refer to Appendix 1, para.2.

(7) On satisfactory completion of the checks, remove the equipment fitted at paragraphs (5) or (6).

Power plant - Adjustment/test (cont.)



T-piece adapter and transducer - water/methanol control unit
Fig.A



Torquemeter pressure digital indicator
Fig.B

D. Record the following ambient conditions (refer to para.F.)

(1) Outside air temperature in degrees C. or F.

(a) Suspend a mercury thermometer from a safe position, adjacent to and in the shade of the aircraft, and record the ambient air temperature.

(2) Pressure altitude in feet.

(a) Obtain the prevailing pressure altitude from the aircraft altimeter by setting it to 1013 millibars and reading off the pressure altitude in feet, above or below sea level.

(3) Dew point in degrees C. or F. If the dew point information is not obtainable record the humidity, using a wet and dry bulb thermometer, and convert to the dew point; refer to Sub-section 4E, 'CHARTS'.

NOTE: If the outside air temperature is below 10 degrees C. (50 degrees F.), humidity corrections are not required.

E. Record the following data (refer to para.F.)

(1) Fuel datum trim position for starting; refer to Section 3, 'ENGINE STARTING, MOTORING AND STOPPING DRILLS'.

(2) Fuel datum trim position for the ambient conditions, corrected for humidity only if the outside air temperature is above 10 degrees C.; refer to Sub-section 4E, 'CHARTS'.

(3) Maximum Data-plate Take-off turbine gas temperature corrected for ambient conditions; refer to Sub-section 4E, 'CHARTS'.

(4) Water/methanol Take-off maximum turbine gas temperature limit; refer to Section 1, 'ENGINE HANDLING', para.5.

(5) Data-plate water/methanol check pressure.

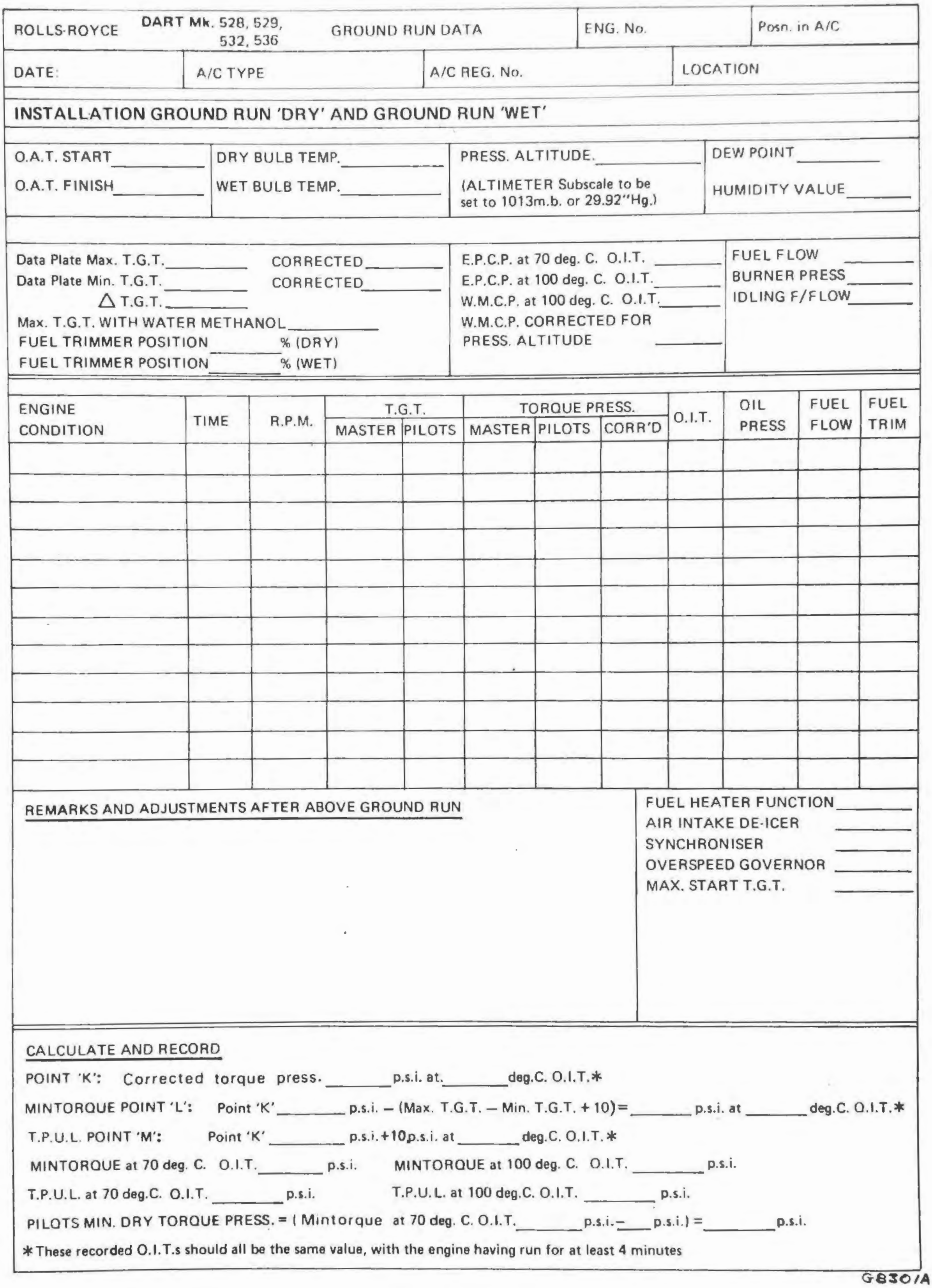
(6) Engine power check pressure at 70 and 100 degrees C. oil inlet temperature for the same shaft horse-power.

NOTE: The information required for para.(5) and (6) can be obtained from the engine 'Inspection and Test Certificate' which can be found in the engine log-book.

Power plant - Adjustment/test (cont.)

F. Engine ground run pro forma

(1) Fig.503A shows a specimen engine ground run pro forma which may be completed for each ground run, as instructed in para.4., 5. and 6., and retained for record and/or reference purposes.



ROLLS-ROYCE DART Mk. 528, 529, 532, 536 GROUND RUN DATA
ENG. No.
Posn. in A/C
DATE:
A/C TYPE
A/C REG. No.
LOCATION

INSTALLATION GROUND RUN 'DRY' AND GROUND RUN 'WET'

O.A.T. START________
O.A.T. FINISH________
DRY BULB TEMP.________
WET BULB TEMP.________
PRESS. ALTITUDE.________
(ALTIMETER Subscale to be set to 1013m.b. or 29.92"Hg.)
DEW POINT ________
HUMIDITY VALUE________

Data Plate Max. T.G.T.________ CORRECTED________
Data Plate Min. T.G.T.________ CORRECTED________
△ T.G.T.________
Max. T.G.T. WITH WATER METHANOL________
FUEL TRIMMER POSITION________% (DRY)
FUEL TRIMMER POSITION________% (WET)
E.P.C.P. at 70 deg. C. O.I.T. ________
E.P.C.P. at 100 deg. C. O.I.T. ________
W.M.C.P. at 100 deg. C. O.I.T.________
W.M.C.P. CORRECTED FOR PRESS. ALTITUDE ________
FUEL FLOW ________
BURNER PRESS________
IDLING F/FLOW________

ENGINE CONDITION	TIME	R.P.M.	T.G.T.		TORQUE PRESS.			O.I.T.	OIL PRESS	FUEL FLOW	FUEL TRIM
			MASTER	PILOTS	MASTER	PILOTS	CORR'D				

REMARKS AND ADJUSTMENTS AFTER ABOVE GROUND RUN

FUEL HEATER FUNCTION________
AIR INTAKE DE-ICER ________
SYNCHRONISER ________
OVERSPEED GOVERNOR ________
MAX. START T.G.T. ________

CALCULATE AND RECORD

POINT 'K': Corrected torque press.________p.s.i. at________deg.C. O.I.T.✱
MINTORQUE POINT 'L': Point 'K'________ p.s.i. – (Max. T.G.T. – Min. T.G.T. + 10)=________ p.s.i. at ________deg.C. O.I.T.✱
T.P.U.L. POINT 'M': Point 'K'________ p.s.i.+10p.s.i. at________deg.C. O.I.T.✱
MINTORQUE at 70 deg. C. O.I.T.________ p.s.i. MINTORQUE at 100 deg. C. O.I.T. ________ p.s.i.
T.P.U.L. at 70 deg.C. O.I.T. ________ p.s.i. T.P.U.L. at 100 deg.C. O.I.T. ________ p.s.i.
PILOTS MIN. DRY TORQUE PRESS. = (Mintorque at 70 deg. C. O.I.T.________p.s.i.–____p.s.i.) =________p.s.i.
✱These recorded O.I.T.s should all be the same value, with the engine having run for at least 4 minutes

Specimen engine ground run pro forma
Fig.503A

]

Power plant - Adjustment/test (cont.)

3. Abbreviations

Wherever possible, abbreviations have been avoided, however, because of space restrictions some abbreviations have been used in the tables and illustrations. Listed below are the abbreviations and their definitions.

C.	Centigrade
E.P.C.P.	engine power check pressure
F.	Fahrenheit
F.C.U.	fuel control unit
F.F.P.S.	flight fine pitch stop
ft.	feet
G.P.C.P.	ground power check pressure
I.S.A.	International standard atmosphere
Max.	maximum
Mk.	Mark
Min.	minimum
Mod.	modification
O.A.T.	outside air temperature
O.I.T.	oil inlet temperature
P.A.	pressure altitude
P.C.U.	propeller controller unit
p.s.i.	pounds per square inch
r.p.m.	revolutions per minute
S.B.	Service Bulletin
S.H.P.	shaft horse-power
S.L.	sea level
T.O.	Take-off
T.P.U.L.	Torque pressure upper limit
T.V.	throttle valve
T.G.T.	turbine gas temperature
w/m	water/methanol
W.M.C.P.	water/methanol check pressure
W.M.C.U.	water/methanol control unit

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JT
Alr
MDa
DG

INSTALLATION GROUND RUN - DRY

1. Object of ground run

A. To interconnect the engine controls so that at the correct Take-off r.p.m. the engine will run at the correct turbine gas temperature (T.G.T.).

B. To establish the Mintorque values; this is an installed torque pressure which is used as a datum to check minimum dry power in service.

C. To establish the torque pressure upper limit (T.P.U.L.) value; this is an installed torque pressure which determines the maximum dry torque pressure allowed in service.

D. To establish the pilots' minimum dry torque pressure.

E. To check that all engine systems are acceptable for service.

2. Action required before commencing installation ground run

A. Instrumentation and pyrometry.

(1) Ensure that the r.p.m. gauge is accurately calibrated.

(2) Ensure that the engine and the associated aircraft pyrometry systems are fully serviceable and that the T.G.T. gauge is accurately calibrated; refer to Chap.77 'ENGINE INDICATING'.

(3) To check the T.G.T. and cross-check the aircraft T.G.T. gauge connect a Foster Potentiometer, type 3154/1883, 3155/DP, 3156/DP or Potentiometer R.R. type GZ.38989 to the aircraft T.G.T. cable terminals in the engine thermocouples main junction box (leave the aircraft T.G.T. cable terminals connected) using a suitable length of Chromel/ Alumel or Copper/Constantan cable; on R.R. type GZ.38989 either No.1 or No.2 input terminals may be used. Ensure that correct polarity is maintained; the Alumel cable and the Constantan cable are magnetic (NEGATIVE).

NOTE: Sixty feet of cable (ERE 2255) will allow the potentiometer to be operated in the crew compartment. The cable length can be adjusted to suit the particular installation.

(a) Position the potentiometer in the place where it will be operated, for approximately 15 minutes, before any readings are taken; this will allow the carcase temperature of the potentiometer to stabilise.

Power plant - Adjustment/test (cont.)

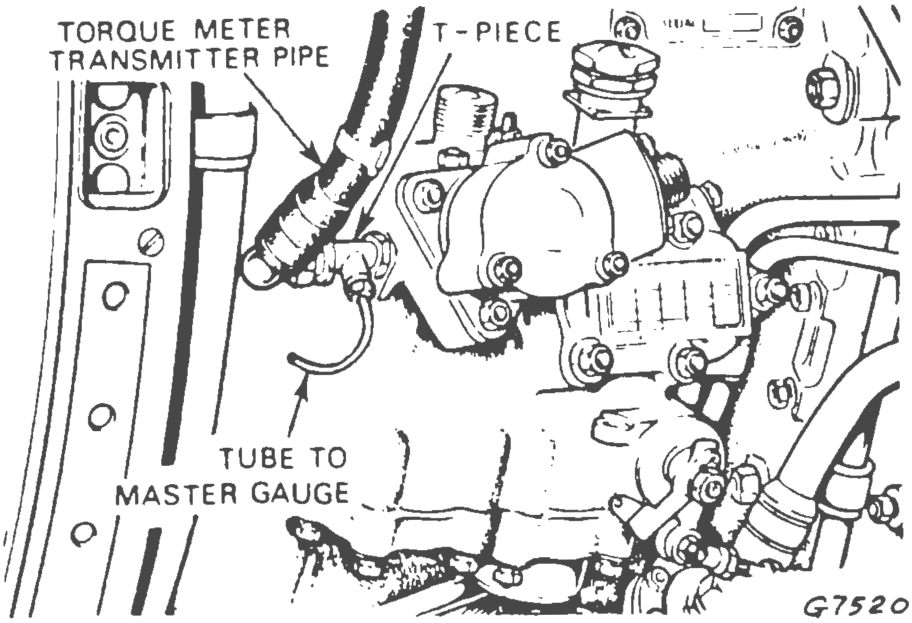
(b) Ensure that the range cap is securely connected on the 60 M.V. socket, and that the potential divider switch is OFF. When using R.R. type GZ.38989, select 60 M.V. on the M.V. switch (situated on the bottom right side of the instrument panel) by moving the switch to the right.

(c) Zero the galvanometer, with button K1 pressed, by rotating the standardising rheostat knob (clockwise moves the needle to the right). On R.R. type GZ.38989 ensure that the galvanometer switch is not in the off position, then push the lever of the MEASURE/STANDARDISE switch to STANDARDISE and zero the galvanometer using the standardising rheostat knob (clockwise moves the needle to the right). If any difficulty is experienced in stabilising or adjusting the needle, renew the batteries.

(d) Obtain the potentiometer terminal temperature from the mercury thermometer attached to the carcase of the potentiometer, then set this temperature on the cold junction scale (C.J. scale, black numerals).

(e) Set the main temperature scale (0 - 1400 degrees C., black numerals) to approximately the required T.G.T. (this will avoid damage to the galvanometer by excessive deflections when the T.G.T. readings are taken during the ground run).

NOTE: Refer to ACTION 4.D. for the method of operation of the Foster Potentiometer when checking the T.G.T. at maximum Take-off conditions.



T-piece adapter - water/methanol control unit
Fig.503

(4) Connect a Bourdon tube type master pressure gauge (GZ.36755) between the torque pressure transmitter oil pipe and the connection on the water/methanol control unit, using a T-piece adapter and a suitable length of tubing (Fig.503).

B. Record the following ambient conditions (refer to para.D.)

(1) Outside air temperature in degrees C. or F.

(a) Suspend a mercury thermometer from a safe position, adjacent to and in the shade of the aircraft, and record the ambient air temperature.

(2) Pressure altitude in feet.

(a) Obtain the prevailing pressure altitude from the aircraft altimeter by setting it to 1013 millibars and reading off the pressure altitude in feet, above or below sea level.

(3) Dew point in degrees C. or F. If the dew point information is not obtainable record the humidity, using a wet and dry bulb thermometer, and convert to the dew point; refer to Sub-section 4E, 'CHARTS'.

NOTE: If the outside air temperature is below 10 degrees C. (50 degrees F.), humidity corrections are not required.

C. Record the following data (refer to para.D.)

(1) Fuel datum trim position for starting; refer to Section 3, 'ENGINE STARTING, MOTORING AND STOPPING DRILLS'.

(2) Fuel datum trim position for the ambient conditions, corrected for humidity only if the outside air temperature is above 10 degrees C.; refer to Sub-section 4E, 'CHARTS'.

(3) Maximum Data-plate Take-off turbine gas temperature corrected for ambient conditions; refer to Sub-section 4E, 'CHARTS'.

(4) Water/methanol Take-off maximum turbine gas temperature limit; refer to Section 1, 'ENGINE HANDLING', para.5.

(5) Data-plate water/methanol check pressure.

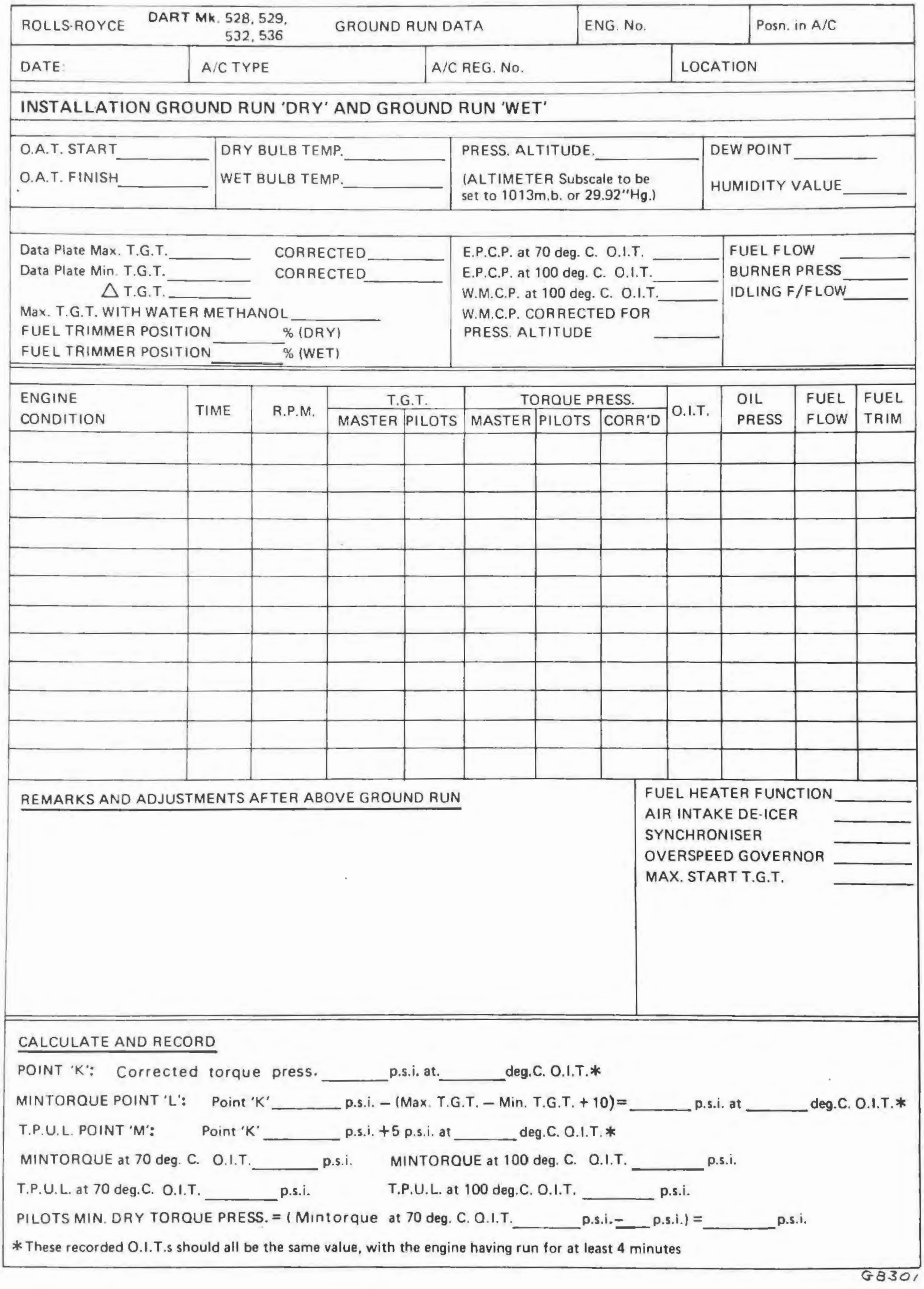
(6) Engine power check pressure at 70 and 100 degrees C. oil inlet temperature for the same shaft horse-power.

NOTE: The information required for para.(5) and (6) can be obtained from the engine 'Inspection and Test Certificate' which can be found in the engine log-book.

Power plant - Adjustment/test (cont.)

D. Engine ground run pro forma

(1) Fig.503A shows a specimen engine ground run pro forma which may be completed for each ground run, as instructed in para.4., 5. and 6., and retained for record and/or reference purposes.



ROLLS-ROYCE	DART Mk. 528, 529, 532, 536	GROUND RUN DATA	ENG. No.	Posn. in A/C

DATE:	A/C TYPE	A/C REG. No.	LOCATION

INSTALLATION GROUND RUN 'DRY' AND GROUND RUN 'WET'

O.A.T. START ____
O.A.T. FINISH ____
DRY BULB TEMP. ____
WET BULB TEMP. ____
PRESS. ALTITUDE. ____
(ALTIMETER Subscale to be set to 1013m.b. or 29.92"Hg.)
DEW POINT ____
HUMIDITY VALUE ____

Data Plate Max. T.G.T. ____ CORRECTED ____
Data Plate Min. T.G.T. ____ CORRECTED ____
△ T.G.T. ____
Max. T.G.T. WITH WATER METHANOL ____
FUEL TRIMMER POSITION ____ % (DRY)
FUEL TRIMMER POSITION ____ % (WET)
E.P.C.P. at 70 deg. C. O.I.T. ____
E.P.C.P. at 100 deg. C. O.I.T. ____
W.M.C.P. at 100 deg. C. O.I.T. ____
W.M.C.P. CORRECTED FOR PRESS. ALTITUDE ____
FUEL FLOW ____
BURNER PRESS ____
IDLING F/FLOW ____

ENGINE CONDITION	TIME	R.P.M.	T.G.T.		TORQUE PRESS.			O.I.T.	OIL PRESS	FUEL FLOW	FUEL TRIM
			MASTER	PILOTS	MASTER	PILOTS	CORR'D				

REMARKS AND ADJUSTMENTS AFTER ABOVE GROUND RUN

FUEL HEATER FUNCTION ____
AIR INTAKE DE-ICER ____
SYNCHRONISER ____
OVERSPEED GOVERNOR ____
MAX. START T.G.T. ____

CALCULATE AND RECORD

POINT 'K': Corrected torque press. ____ p.s.i. at ____ deg.C. O.I.T.*
MINTORQUE POINT 'L': Point 'K' ____ p.s.i. – (Max. T.G.T. – Min. T.G.T. + 10) = ____ p.s.i. at ____ deg.C. O.I.T.*
T.P.U.L. POINT 'M': Point 'K' ____ p.s.i. +5 p.s.i. at ____ deg.C. O.I.T.*
MINTORQUE at 70 deg. C. O.I.T. ____ p.s.i.   MINTORQUE at 100 deg. C. O.I.T. ____ p.s.i.
T.P.U.L. at 70 deg.C. O.I.T. ____ p.s.i.   T.P.U.L. at 100 deg.C. O.I.T. ____ p.s.i.
PILOTS MIN. DRY TORQUE PRESS. = (Mintorque at 70 deg. C. O.I.T. ____ p.s.i. – ____ p.s.i.) = ____ p.s.i.

*These recorded O.I.T.s should all be the same value, with the engine having run for at least 4 minutes

G830/

Specimen engine ground run pro forma
Fig.503A

Power plant - Adjustment/test (cont.)

E. Overspeed governor check

(1) Set the overspeed governor as instructed in Chap.73-2, 'FUEL PUMP MAINTENANCE PRACTICES', 3. Adjustment/test, para.A.

3. Abbreviations

Wherever possible, abbreviations have been avoided, however, because of space restrictions some abbreviations have been used in the tables and illustrations. Listed below are the abbreviations and their definitions.

C.	Centigrade
E.P.C.P.	engine power check pressure
F.	Fahrenheit
F.C.U.	fuel control unit
F.F.P.S.	flight fine pitch stop
ft.	feet
G.P.C.P.	ground power check pressure
I.S.A.	International standard atmosphere
Max.	maximum
Mk.	Mark
Min.	minimum
Mod.	modification
O.A.T.	outside air temperature
O.I.T.	oil inlet temperature
P.A.	pressure altitude
P.C.U.	propeller controller unit
p.s.i.	pounds per square inch
r.p.m.	revolutions per minute
S.B.	Service Bulletin
S.H.P.	shaft horse-power
S.L.	sea level
T.O.	Take-off
T.P.U.L.	Torque pressure upper limit
T.V.	throttle valve
T.G.T.	turbine gas temperature
w/m	water/methanol
W.M.C.P.	water/methanol check pressure
W.M.C.U.	water/methanol control unit

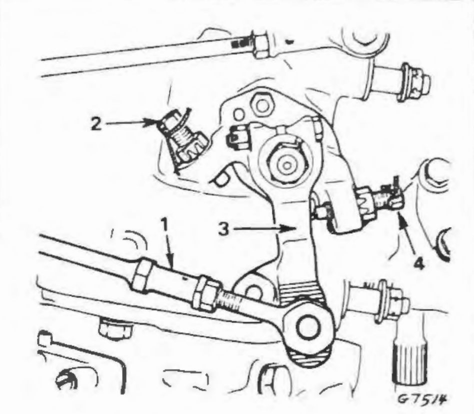
Power plant - Adjustment/test (cont.)

TABLE 2

4. Ground run sequence

ACTION	CHECK	ACCEPTANCE LIMITS	ACTION IF INCORRECT	RECTIFICATION, CALCULATION AND ILLUSTRATIONS
NOTE: Actions A. B. and D. are for checking the engine interconnection; action C. is for function checking the hot-air valve.				
A. Set the FUEL DATUM: start the engine as instructed in Section 3, 'ENGINE STARTING, MOTORING AND STOPPING DRILLS'	Oil pressure	Needle off the stop	Stop the engine	Refer to 'POWER PLANT - TROUBLE SHOOTING', Oil system defects (page block 101).
	T.G.T. during start	Maximum: 930 degrees C.	Stop the engine	Refer to 'POWER PLANT - TROUBLE SHOOTING', Engine starting faults (page block 101).
	T.G.T. when stabilized	Maximum: 550 degrees C.	Stop the engine	Refer to 'POWER PLANT - TROUBLE SHOOTING', Engine starting faults (page block 101).
	Oil inlet temperature	Minimum: minus 15 degrees C.	Run engine at up to 11,000 r.p.m. to achieve the required minimum temperature	
B. Set the FUEL DATUM for ambient conditions; refer to Sub-section 4E 'CHARTS'. Correct this setting for humidity if the outside air temperature is plus 10 degrees C. and above; refer to Sub-section 4E 'CHARTS'.				
C. Set the throttle to obtain 10,000 r.p.m. approximately	Immediately the throttle is moved check the low oil pressure warning light	Light is extinguished when the oil pressure reaches 5 to 6 p.s.i.	Stop the engine	Refer to 'POWER PLANT - TROUBLE SHOOTING' Oil system defects (page block 101).
	Oil pressure	Steady increase	Stop the engine	Refer to 'POWER PLANT - TROUBLE SHOOTING', Oil system defects, (page block 101).
(1) 2-position valve or 3-position valve (Mod. 1397) with half-heat unused (Mod.1434):	Hot air valve (fuel heater)			
Switch fuel heater ON		Small reduction in r.p.m. (approximately 50 r.p.m.)	Feel for hot air discharge from heater	Refer to Chapter 75-1-1, 'MAINTENANCE PRACTICES - HOT AIR VALVE'
Switch fuel heater OFF		R.p.m. restored to original value	Feel that discharge has ceased entirely	

TABLE 2 (cont.)

ACTION	CHECK	ACCEPTANCE LIMITS	ACTION IF INCORRECT	RECTIFICATION, CALCULATIONS AND ILLUSTRATIONS
C. (cont.)				
(2) 3-position valve (Mod.1397):				
Switch fuel heater ON.				
Select HALF heat		Small reduction in r.p.m. (approximately 50 r.p.m.)	Feel for warm air discharge from heater	Refer to Chapter 75-1-1, 'MAINTENANCE PRACTICES - HOT AIR VALVE'
Select FULL heat		Further small reduction in r.p.m. (approximately 50 r.p.m.)	Feel for hot air discharge from heater	
Switch fuel heater OFF		R.p.m. restored to original value	Feel that discharge has ceased entirely	
NOTES: (1) Since oil inlet temperature increases with time at full throttle, the checks in ACTION D are listed in sequence of increasing oil inlet temperature. (2) Ensure that unnecessary electrical load is switched off and that cabin compressors are unloaded.				 R.p.m. control lever and stops Fig.504
D. Open the throttle fully	R.p.m.	Minimum: 15,000 r.p.m. Maximum: 15,050 r.p.m.	Stop the engine	(1) Refer to 'POWER PLANT - TROUBLE SHOOTING', R.p.m. faults (page block 101). (2) If the error exceeds 400 r.p.m. do not attempt to reset the engine r.p.m. before checking instrumentation and propeller equipment. (3) Adjust the rod length (1) between the propeller control unit r.p.m. control lever (3) and the cross shaft lever (Fig.504). NOTE: One turn of the rod (1) clockwise (viewed from the rear of the engine) should increase the maximum engine r.p.m. by 200 approximately.
	Oil inlet temperature	Minimum: 65 degrees C. Maximum: 75 degrees C.	If below 65 degrees C. continue run until this temperature is achieved; if above 75 degrees C. run at idle until below this temperature	(4) Open and shut the pilot's throttle lever fully and check that the propeller control unit r.p.m. control lever (3) is at least 0.050 in. clear of the maximum and minimum stops (4) and (2); adjust the stops as necessary.
	Oil pressure; record observed pressure	Normal: 12 to 35 p.s.i.	Stop the engine	Refer to 'POWER PLANT - TROUBLE SHOOTING', Oil system defects' (page block 101).

D. Turbine gas temperature (cont.) ***

(1) Use Foster Potentiometer, types 3154/1883, 3155/DP or 3156/DP; refer to para.2.A. (3)(a) to (e).

(a) Press button K2 and zero the galvanometer by rotating the main scale knob (clockwise moves the needle to the right).

(b) When the galvanometer has no deflections, with button K2 pressed, the T.G.T. reading is stabilised and can be read from the potentiometer main scale and the aircraft T.G.T. gauge.

(c) It is essential to repeat the instructions in para.2.A.(3)(c) and (d) at regular intervals to ensure that the galvanometer remains zeroed.

(2) Use Potentiometer R.R. type GZ.38989; refer to para.2.A.(3)(a) to (e).

(a) Select 1 or 2 on the left-hand rotary switch, depending on the input terminals being used.

(b) Select the OFF position on the right-hand rotary switch.

(c) Push the lever of the MEASURE/STANDARDISE switch to MEASURE and zero the galvanometer, using the main scale adjustment knob (clockwise moves the needle to the right).

(d) When the galvanometer has no deflections, with MEASURE selected, the T.G.T. reading is stabilised and can be read from the potentiometer main scale and the aircraft T.G.T. gauge.

(e) It is essential to repeat the instructions in para.2.A.(3)(c) and (d) at regular intervals to ensure that the galvanometer remains zeroed.

TABLE 2 (cont.)

ACTION	CHECK	ACCEPTANCE LIMITS	ACTION IF INCORRECT	RECTIFICATION, CALCULATIONS AND ILLUSTRATIONS
D. (cont.)				
Continue running engine at full throttle for a minimum of 4 minutes	Torque pressure; record observed pressure shown on aircraft and master torque pressure gauge; refer to para.2.A.(4). Record T.G.T.	Refer to 5. 'Determine the torque pressure limits'. NOTE: This instruction is located immediately following TABLE 2.		
	Oil inlet temperature and record same	Min. 85 degrees C. Max. 100 degrees C.	Refer to Section 4, 'ENGINE GROUND RUNNING PROCEDURES', para.8.C.	
If necessary, continue running engine at full throttle until T.G.T. has stabilized Min. 4 minutes Max. 5 minutes	Turbine gas temperature * * *	Corrected DATA-PLATE TAKE-OFF MAX. T.G.T. plus 0 degrees C. and minus 5 degrees C. Refer to Sub-section 4E, 'CHARTS' for T.G.T. corrections.	Stop the engine; re-set the controls to obtain the correct T.G.T. then re-start the ground run at the commencement of Action D. NOTE: Ensure that oil inlet temperature is below 70 degrees C. before re-commencing ground run.	Refer to para.7., Re-set the engine controls.
	Oil inlet temperature	120 degrees C. MAXIMUM		

Power plant - Adjustment/test (cont.)

TABLE 2 (cont.)

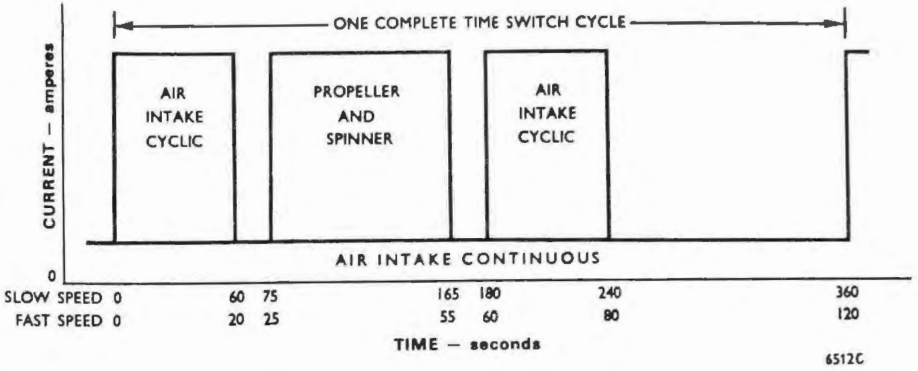
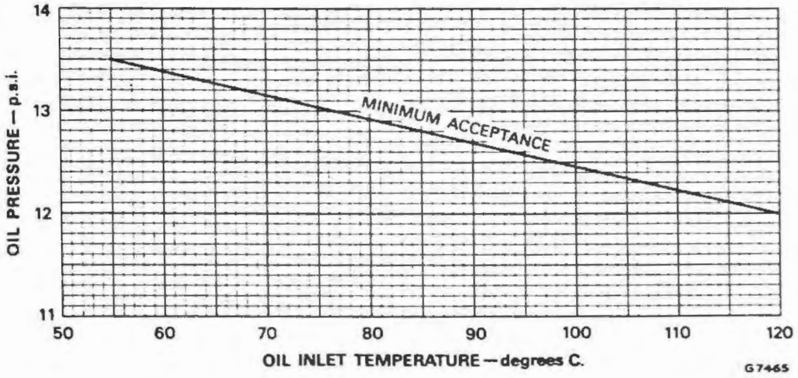
ACTION	CHECK	ACCEPTANCE LIMITS	ACTION IF INCORRECT	RECTIFICATION, CALCULATIONS AND ILLUSTRATIONS
NOTE: Action E.(1) is to check, if required, the power unit ice protection system; action E.(2) is to check the oil pressure.				
E. (1) Set the throttle to obtain 12,800 r.p.m.	Power unit ice protection system (only if required)	Refer to Fig.505	Refer to Chapter 30, 'ICE AND RAIN PROTECTION'	 ONE COMPLETE TIME SWITCH CYCLE AIR INTAKE CYCLIC PROPELLER AND SPINNER AIR INTAKE CYCLIC AIR INTAKE CONTINUOUS CURRENT — amperes 0 SLOW SPEED 0 60 75 165 180 240 360 FAST SPEED 0 20 25 55 60 80 120 TIME — seconds 6512C Power unit ice protection system switch sequence Fig.505
(2) Set the throttle to obtain 12,000 r.p.m.	Oil inlet temperature	Minimum: 55 degrees C. Maximum: 120 degrees C.	Run to warm up	
	Oil pressure	Minimum: $13^{1}/_{2}$ p.s.i. at 55 degrees C. and pro-rata down to 12 p.s.i. at 120 degrees C. and above; refer to Fig.506 Maximum: 35 p.s.i. at any temperature If oil pressure is below minimum, run at maximum continuous r.p.m.; accept engine if oil pressure is not less than $13^{1}/_{2}$ p.s.i. at 55 degrees C. and pro-rata down to 12 p.s.i. at 120 degrees C.	Stop the engine	Refer to 'POWER PLANT - TROUBLE SHOOTING', oil system defects (page block 101)  Minimum oil pressure limitation graph Fig.506

TABLE 2 (cont.)

ACTION	CHECK	ACCEPTANCE LIMITS	ACTION IF INCORRECT	RECTIFICATION, CALCULATION AND ILLUSTRATIONS
NOTE: Actions F. and G. are for checking the minimum constant speeding r.p.m. and the ground idling r.p.m.				
F. Set the FUEL DATUM to 50 per cent. Set the throttle to obtain 50 p.s.i. torque pressure, then vary the FUEL DATUM between 30 per cent and 70 per cent.	Minimum constant speeding r.p.m. (minimum governed speed)	R.p.m. must remain constant and must be within the following limits 10,850 and 11,150 r.p.m.	Stop the engine	Chap.61, 'PROPELLER CONTROLLER UNIT - MAINTENANCE PRACTICES'.
G. Close the throttle and set the FUEL DATUM as follows: For Mk.536-7P and 536-7R engines, 85 per cent. For all other engine Mks., 100 per cent.	Ground idling r.p.m.	Between 6,500 and 7,500 r.p.m.	Stop the engine	Refer to 'POWER PLANT - TROUBLE SHOOTING', r.p.m. faults (page block 101).
H. Proceed with wet ground run; refer to Sub-section 4B 'GROUND RUN - WET'.				

5. Determine the torque pressure limits

A. Correct the observed torque pressure to I.S.A. S.L. value.

(1) Mk.528, 532, 536 and variants.

(a) For pressure altitudes of 3,000 feet or less, refer to Fig.522, Sub-section 4E 'CHARTS'.

(b) For pressure altitudes of 3,000 feet to 10,000 feet, refer to Fig.524, Sub-section 4E 'CHARTS'.

(2) Mk.529 and variants.

(a) For pressure altitudes of 3,000 feet or less, refer to Fig.523, Sub-section 4E 'CHARTS'.

(b) For pressure altitudes of 3,000 feet to 10,000 feet, refer to Fig.525, Sub-section 4E 'CHARTS'.

(3) Mk.532-7P and 536-7P only.

(a) For pressure altitudes of 10,000 to 15,000 feet, refer to Fig.526, Sub-section 4E 'CHARTS'.

(4) If the outside air temperature is below 10 degrees C. a humidity correction is not required. If the outside air temperature is above 10 degrees C. obtain a humidity correction as follows.

(a) To obtain a humidity correction factor from graph E (Fig.522 to 526, Sub-section 4E 'CHARTS') read from the dew point scale to the required pressure altitude, then across to the left hand axis. Show the resultant humidity correction factor as a short line at the correct value parallel to the existing humidity correction lines already drawn on graph B.

(5) To correct the observed torque pressure use the recorded ambient conditions, the observed torque pressure and the oil inlet temperature; refer to Fig.522 to 526, Sub-section 4E 'CHARTS'.

NOTE: For each degree of T.G.T. that the engine is set below the Data-plate maximum Take-off T.G.T., add 1 p.s.i. to the observed torque pressure.

(a) Start at graph A, read from the outside air temperature scale to the required pressure altitude, then across to graph B to the humidity correction factor obtained in para.(4)(a). When a humidity correction factor is not required read to the zero humidity correction line.

Power plant - Adjustment/test (cont.)

(b) Read down from graph B to the observed torque pressure value on graph C; read across from this value to the left hand vertical axis of graph D to obtain the corrected torque pressure ; record this figure.

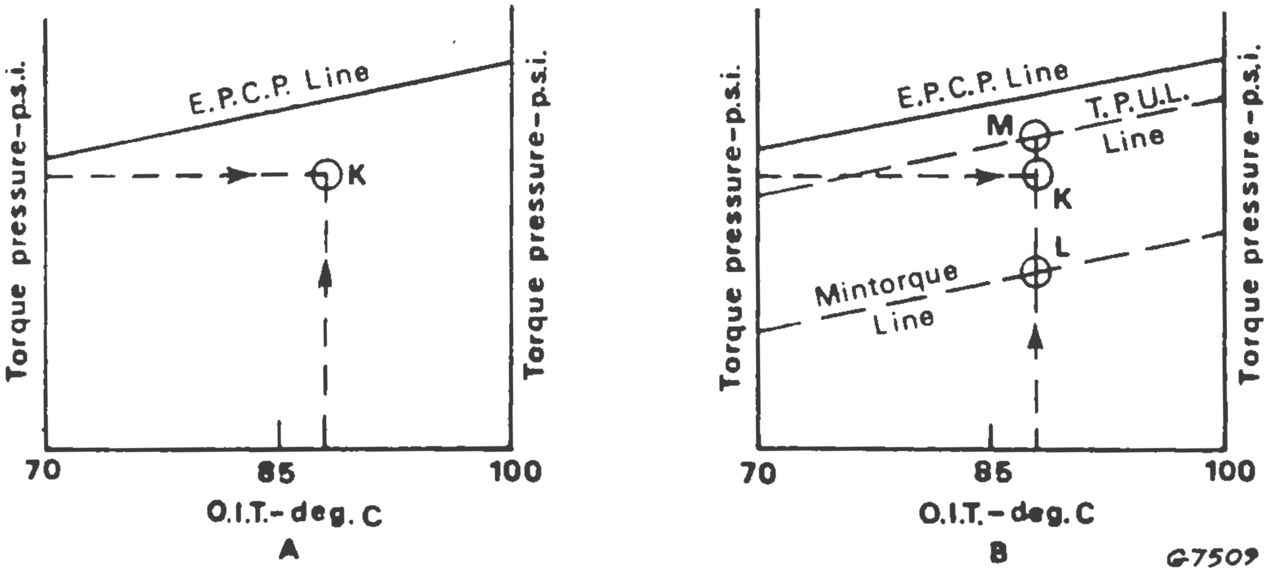
NOTE: The value of each small square on the left hand vertical axis of graph D is 4 p.s.i.

B. Calculate the Mintorque

(1) Produce a graph similar to graph D on Fig.522 to 526, Sub-section 4E 'CHARTS' (do not include the lines shown only for example).

(2) On the prepared graph (using the previously recorded figures) mark the engine power check pressure (E.P.C.P.) for 70 degrees C. oil inlet temperature on the left-hand vertical axis and the E.P.C.P. for 100 degrees C. oil inlet temperature on the right-hand vertical axis. Join the respective points to produce a line similar to the line illustrated in the example (Fig.507'A').

(3) Draw a horizontal line from the point on the left-hand vertical axis corresponding to the corrected torque pressure. Draw a vertical line from the point on the horizontal axis at the oil inlet temperature observed when the torque pressure was recorded during the ground run. Call the point of intersection 'K' (Fig.507'A').



Example of the use of graph D
Fig.507

(4) Subtract the Data-plate minimum turbine gas temperature from the Data-plate maximum turbine gas temperature and add 10 to the resultant value.

(Data-plate maximum T.G.T. - Data-plate minimum T.G.T.) + 10

NOTE: For the purpose of this calculation one degree C. of turbine gas temperature is equivalent to one p.s.i. of torque pressure.

(5) Subtract the result obtained as a p.s.i. value from point 'K' and plot this value, calling it point 'L', at the same oil inlet temperature as point 'K' (Fig.507'B').

(6) Draw a line through point 'L' parallel to the E.P.C.P. line to obtain reference Mintorque values between 70 and 100 degrees C. oil inlet temperatures.

C. Acceptance limits

(1) If the Mintorque line lies between the E.P.C.P. line minus 15 p.s.i. and the E.P.C.P. line minus 60 p.s.i. the engine is acceptable for service. If not, refer to 'POWER PLANT - TROUBLE SHOOTING', Torque pressure defects' (page block 101).

D. Calculate the torque pressure upper limit (T.P.U.L.)

(1) Plot a point (shown as 'M' in Fig.507'B') 5 p.s.i. greater than, and at the same oil inlet temperature as point 'K'.. Draw a line through point 'M' parallel to the E.P.C.P. line to obtain reference T.P.U.L. values between 70 and 100 degrees C. oil inlet temperatures (Fig.507'B').

E. Subtract 25 p.s.i. from the Mintorque value at 70 degrees C. oil inlet temperature and placard the value obtained in the crew compartment.

NOTE: This value is the pilots' minimum 'dry' torque pressure limit, and when corrected for ambient conditions is used by the pilot to check 'dry' TAKE-OFF power.

6. Documentation

A. Record the following information in the engine log-book and appropriate aircraft documents.

(1) The Mintorque values at 70 and 100 degrees C. oil inlet temperature.

(2) The torque pressure upper limit values at 70 and 100 degrees C. oil inlet temperature.

(3) The oil inlet temperature at which point 'K' was recorded; refer to para.5.B.(3).

(4) Pilots' minimum 'dry' torque pressure value.

7. Re-set the engine controls (Fig.508)

NOTE: To ensure consistent results always set the fuel datum position indicator from a lower value.

A. Re-set the controls if there is sufficient adjustment on the control box adjustable stop.

(1) Re-set the controls to obtain the required turbine gas temperature.

(a) Open the pilot's throttle lever fully and set the FUEL DATUM position indicator to FULL INCREASE (100 per cent) for all engine Mks.

(b) Adjust the rod length (5) between the throttle valve lever (2) and the engine control box to obtain the required turbine gas temperature, adjusting the fuel control unit maximum stop (1) to obtain not less than 0.050 in. clearance.

NOTE: One sixth of a turn of the rod (5) anti-clockwise (viewed from the rear of the engine) increases the turbine gas temperature approximately 3 degrees C.

(c) Close the pilots' throttle lever fully and set the FUEL DATUM position indicator to:

Mk.536-7P, 536-7R and 535-7	-	85 per cent
All other Mks.	-	100 per cent

(d) Adjust the engine control box adjustable stop (8), (with the throttle pick-up lever (6),contacting it) to obtain a clearance between the throttle valve lever (2) and the fuel control unit minimum stop (3) of:

Modification standard	Minimum stop (3) clearance	Adjustable stop (8) projection limits
Pre-Mod.1138	0.100 in.	0.0 in. to 0.100 in.
Mod.1138 (S.B.Da72-151) but pre-Mod.1523	0.120 in.	0.0 in. to 0.175 in.
Mod.1523 (S.B.Da73-55)	0.140 in.	0.0 in. to 0.225 in.

(2) If permissible adjustment is insufficient, re-set the throttle valve lever as instructed in para.B.

Power plant - Adjustment/test (cont.)

B. Re-set the controls if there is insufficient adjustment on the control box adjustable stop

(1) Set a datum position for maximum Take-off fuel flow.

(a) Open the pilot's throttle lever fully and set the FUEL DATUM position indicator to:

Mk.536-7P, 536-7R and 535-7 - 85 per cent

All other Mks. - 100 per cent

(b) To provide the datum position, adjust the fuel control unit maximum stop (1) to just contact the throttle valve lever (2) ensuring that the throttle pick-up lever (6) contacts the engine control box maximum stop (7).

(2) Re-set the controls box adjustable stop to mid-travel.

(a) Set the controls box adjustable stop (8) projection to:

Pre-Mod.1138	0.050 in.
Mod.1138 (S.B.Da72-151) but pre-Mod.1523	0.090 in.
Mod.1523 (S.B.Da73-55)	0.110 in.

(b) Close the pilot's throttle lever fully, retaining the FUEL DATUM position previously set in para.B. (1)(a) and ensure that the throttle pick-up lever (6) contacts the engine control box adjustable stop (8).

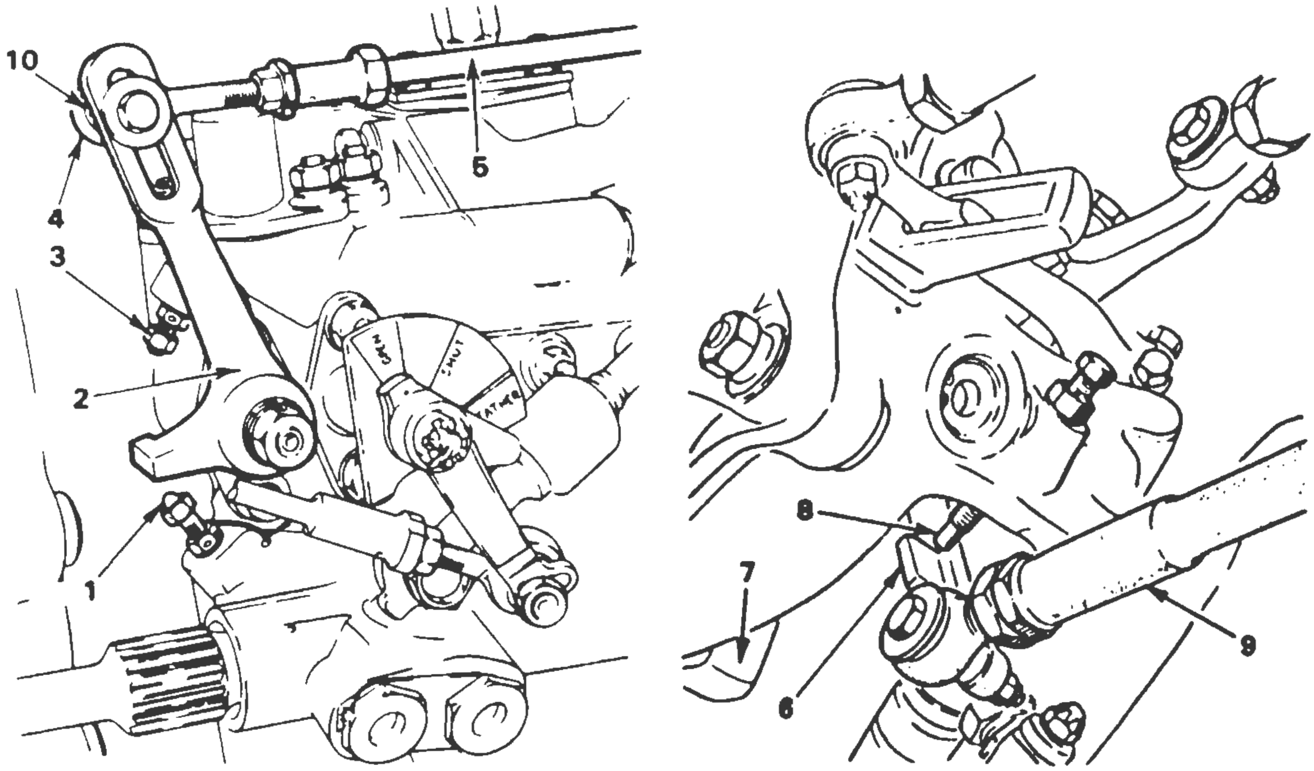
(3) Re-set the throttle valve lever travel.

(a) Measure the clearance between the throttle valve lever (2) and the fuel control unit minimum stop (3).

(b) Re-position the throttle valve lever end-coupling (4) one serration inwards for every 0.020 in. that the clearance between the throttle valve lever (2) and the fuel control unit minimum stop (3) exceeds the following dimensions:

Pre-Mod.1138	0.100 in.
Mod.1138 (S.B.Da72-151) but pre-Mod.1523	0.120 in.
Mod.1523 (S.B.Da73-55)	0.140 in.

NOTE: An adjustment of 0.010 in. can be obtained by rotating the serrated washer (10) situated between the end-coupling (4) and the throttle valve lever (2), through 180 degrees.



FUEL CONTROL UNIT

ENGINE CONTROL BOX

1. FUEL CONTROL UNIT MAXIMUM STOP.
2. FUEL CONTROL UNIT THROTTLE VALVE LEVER.
3. FUEL CONTROL UNIT MINIMUM STOP.
4. THROTTLE VALVE LEVER CONTROL ROD END-COUPLING.
5. THROTTLE VALVE LEVER CONTROL ROD.
6. ENGINE CONTROL BOX THROTTLE PICK-UP LEVER.
7. ENGINE CONTROL BOX MAXIMUM (FIXED) STOP.
8. ENGINE CONTROL BOX ADJUSTABLE STOP.
9. AIRCRAFT CONTROL ROD.
10. SERRATED WASHER.

G7542

Control adjustments
Fig.508

(4) Restore the throttle valve lever clearances

(a) Open the pilot's throttle lever fully, retaining the FUEL DATUM position previously set in para.B.(1)(a).

(b) Adjust the control rod (5) length between the throttle valve lever (2) and the engine control box until the throttle valve lever (2) just contacts the fuel control unit maximum stop (1).

(c) Still retaining the FUEL DATUM position previously set, close the pilot's throttle lever fully and ensure that the throttle pick-up lever (6) contacts the engine control box adjustable stop (8).

(d) Adjust the engine control box adjustable stop (8) projection, within the permissible limits, to obtain a clearance between the throttle valve lever (2) and the fuel control unit minimum stop (3) of:

Modification standard	Minimum stop (3) clearance	Adjustable stop (8) projection limits
Pre-Mod.1138	0.100 in.	0.0 in. to 0.100 in.
Mod.1138 (S.B.Da72-151) but pre-Mod.1523	0.120 in.	0.0 in. to 0.175 in.
Mod.1523 (S.B.Da73-55)	0.140 in.	0.0 in. to 0.225 in.

(e) Set the FUEL DATUM position indicator to FULL INCREASE (100 per cent) for all engine Mks.

(f) Open the pilot's throttle lever fully, then adjust the fuel control unit maximum stop (1) to obtain a minimum clearance of 0.050 in. between it and the throttle valve lever (2).

C. Adjust the turbine gas temperature (alternative method)

NOTE: The fuel trim switches are used to adjust the maximum fuel flow and so obtain the desired turbine gas temperature; this limits the use of this method, when near or below I.S.A. conditions, to adjusting for high turbine gas temperature.

(1) Adjust the control rod length (5) to obtain the required maximum turbine gas temperature.

(a) Use the fuel trim switches to reduce the turbine gas temperature below the required value (if necessary), then increase the fuel trim until the required turbine gas temperature indication has stabilized.

(b) Stop the engine without altering the FUEL DATUM setting.

(c) Open the pilot's throttle lever fully (FUEL DATUM setting still unaltered) and ensure that the throttle pick-up lever (6) contacts the engine control box maximum stop (7).

(d) Measure and note the clearance between the fuel control unit maximum stop (1) and the throttle valve lever (2).

(e) Restore the FUEL DATUM to the original setting; refer to 4. 'Ground run sequence', ACTION B.

(f) Adjust the control rod length (5) between the throttle valve lever (2) and the engine control box to give the fuel control unit maximum stop/throttle valve lever clearance obtained in para.(d) above.

(g) Set the FUEL DATUM to full INCREASE (100 per cent) and adjust the fuel control unit maximum stop (1) to obtain a minimum clearance of 0.050 in. between it and the throttle valve lever (2).

(2) Obtain the fuel control unit minimum stop (3) clearance

(a) Close the pilots' throttle lever fully and set the FUEL DATUM position indicator to:

Mk.536-7P, 536-7R and 535-7	-	85 per cent
All other Mks.	-	100 per cent

(b) Adjust the engine control box adjustable stop (8), (with the throttle pick-up lever (6) contacting it) to obtain a clearance between the throttle valve lever (2) and the fuel control unit minimum stop (3) of:

Modification standard	Minimum stop (3) clearance	Adjustable stop (8) projection limits
Pre-Mod.1138	0.100 in.	0.0 in. to 0.100 in.
Mod.1138 (S.B.Da72-151) but pre-Mod.1523	0.120 in.	0.0 in. to 0.175 in.
Mod.1523 (S.B.Da73-55)	0.140 in.	0.0 in. to 0.225 in.

(c) If permissible adjustment is insufficient, re-set the throttle valve lever as instructed in para.B.

(d) Check the engine controls for full and free movement; refer to Chap.76-0, 'MAINTENANCE PRACTICES - ENGINE CONTROLS', SERVICING.

(3) Carry out the controls static checks as instructed in Chap.76-0, 'MAINTENANCE PRACTICES - ENGINE CONTROLS', STATIC CHECKS AND ADJUSTMENTS.

(4) On satisfactory completion of the controls static checks re-start the ground run at the commencement of ACTION D.

GROUND RUN - WET

1. Object of ground run

   A. To check that the water/methanol control system is correctly set so that water/methanol injection will occur and cease at the specified r.p.m.

   B. To check that the torque pressure and the turbine gas temperature are within acceptance limits at the correct maximum r.p.m.

2. Action required before commencing wet ground run

   NOTE: If the wet ground run is carried out as part of the installation ground run the following information will already be recorded.

   A. Record the following data:

      (1) Outside air temperature in degrees C. or F.

         (a) Suspend a mercury thermometer from a safe position, adjacent to and in the shade of the aircraft, and record the ambient air temperature.

      (2) Pressure altitude in feet.

         (a) Obtain the prevailing pressure altitude from the aircraft altimeter by setting it to 1013 millibars and reading off the pressure altitude in feet, above or below sea level.

      (3) Dew point in degrees C. or F. If the dew point information is not obtainable record the humidity, using a wet and dry bulb thermometer, and convert to the dew point; refer to Sub-section 4E,'CHARTS'.

         NOTE: If the outside air temperature is below 10 degrees C. (50 degrees F.), humidity corrections are not required.

      (4) Fuel datum trim position for starting; refer to Section 3, 'ENGINE STARTING, MOTORING AND STOPPING DRILLS'.

      (5) Fuel datum trim position for the ambient conditions, corrected for humidity only if the outside air temperature is above 10 degrees C.; refer to Sub-section 4E,'CHARTS'.

      (6) Water/methanol Take-off maximum turbine gas temperature limit; refer to Section 1, 'ENGINE HANDLING', para.6.

      (7) Data-plate water/methanol check pressure.

3. Abbreviations

Wherever possible, abbreviations have been avoided, however, because of space restrictions some abbreviations have been used in the tables and illustrations. Listed below are the abbreviations and their definitions.

C.	Centigrade
E.P.C.P.	engine power check pressure
F.	Fahrenheit
F.C.U.	fuel control unit
F.F.P.S.	flight fine pitch stop
ft.	feet
G.P.C.P.	ground power check pressure
I.S.A.	International standard atmosphere
Max.	maximum
Mk.	Mark
Min.	minimum
Mod.	modification
O.A.T.	outside air temperature
O.I.T.	oil inlet temperature
P.A.	pressure altitude
P.C.U.	propeller controller unit
p.s.i.	pounds per square inch
r.p.m.	revolutions per minute
S.B.	Service Bulletin
S.H.P.	shaft horse-power
S.L.	sea level
T.O.	Take-off
T.P.U.L.	Torque pressure upper limit
T.V.	throttle valve
T.G.T.	turbine gas temperature
w/m	water/methanol
W.M.C.P.	water/methanol check pressure
W.M.C.U.	water/methanol control unit

TABLE 3

4. Ground run sequence

ACTION	CHECK	ACCEPTANCE LIMITS	ACTION IF INCORRECT	RECTIFICATION, CALCULATIONS AND ILLUSTRATIONS
NOTE: Actions A. to D. are for checking that the water/methanol (w/m) injection occurs within the specified r.p.m.				
A. Set the FUEL DATUM; start the engine as instructed in Section 3 'ENGINE STARTING, MOTORING and STOPPING DRILLS'. After the engine has been started set the FUEL DATUM as follows: For Mk.528 and 529 engines, 70 per cent or less if ambient conditions require. For all other engine Mks., set to ambient conditions; refer to Sub-section 4E 'CHARTS'.	Oil inlet temperature	Minimum: 70 degrees Maximum: 100 degrees C.	If below 70 degrees C. continue run until this temperature is achieved; if above 100 degrees C. run at idle until below this temperature	
B. Maintain the r.p.m. below 14,000 and switch on the w/m system pumps and cocks as required.	That the pressure indicator lamps are illuminated			
C. Slowly open the throttle to obtain 14,500 r.p.m.; pause 10 seconds	That there is no substantial sudden increase in the torque pressure	W/m injection must not occur before 14,500 r.p.m.	Stop the engine	(1) With the throttle lever in the fully open position adjust the w/m unit control lever maximum stop clearance by lengthening the w/m unit/cross shaft control rod to obtain a w/m injection at a higher r.p.m. (2) Check that the w/m control lever maximum stop clearance is not less than: Pre-Mod.927 - 0.100 in. Mod.927 (S.B.DaMisc-14) - 0.150 in. (3) Re-start the engine and repeat Action B. and C.
D. Slowly advance the throttle and pause 10 seconds after each increase of 100 r.p.m.	That a substantial sudden increase in the torque pressure occurs; note the r.p.m. and proceed with E.	W/m injection must occur at or before 14,900 r.p.m.	Stop the engine	(1) With the throttle lever in the fully open position adjust the w/m unit control lever maximum stop clearance by shortening the w/m unit/cross shaft control rod to obtain w/m injection at a lower r.p.m. (2) Check that the w/m unit control lever maximum stop clearance is not less than the appropriate clearance given in item (2) of Action C. (3) Re-start the engine and repeat Action B, C and D.

TABLE 3 (cont.)

ACTION	CHECK	ACCEPTANCE LIMITS	ACTION IF INCORRECT	RECTIFICATION, CALCULATIONS AND ILLUSTRATIONS
NOTE: Actions E. to H. are for checking that the turbine gas temperature (T.G.T.) and torque pressure are within limits and that the water/methanol (w/m) injection ceases within the specified r.p.m.				
E. Open the throttle fully and pause for conditions to stabilize	Turbine gas temperature	Must not exceed the OPERATING LIMITATIONS for TAKE-OFF T.G.T. with water/methanol (refer to Section 1, 'ENGINE HANDLING')	Stop the engine	(1) Check that the water/methanol is to the correct specification; refer to Chap.89-10 'ROLLS-ROYCE SPECIFICATION FOR TYPE 1 WATER/METHANOL MIXTURE'. (2) If a dry ground run has not been carried out immediately prior to a wet ground run, carry out ACTION D, Sub-section 4C 'IN-SERVICE GROUND RUN - DRY'. (3) Refer to 'POWER PLANT - TROUBLE SHOOTING', T.G.T. faults (page block 101).
	Torque pressure	Corrected DATA-PLATE WATER/METHANOL CHECK PRESSURE plus 7 p.s.i. and minus 0 p.s.i. Corrections: Subtract 6 p.s.i. per 1,000 ft. above sea-level (8 p.s.i. for Mk.532-7N engines) Add 6 p.s.i. per 1,000 ft. below sea-level (8 p.s.i. for Mk.532-7N engines)	Stop the engine	(1) Refer to 'POWER PLANT - TROUBLE SHOOTING', Torque pressure faults (page block 101). (2) If necessary adjust the w/m unit as instructed in Chap.82-1, 'WATER/METHANOL CONTROL UNIT - MAINTENANCE PRACTICES', para.2. NOTE: Turn the adjusting piece anti-clockwise to increase the controlling pressure and vice versa. (3) Re-start the engine and repeat the wet ground run.
F. Set the throttle to obtain 14,500 r.p.m., pause for 15 seconds	Torque pressure	W/m injection must cease at or before 14,500 r.p.m.	Stop the engine	See Action C. items (1) to (3) under Rectification, Calculations and Illustrations
G. Switch off w/m system pumps and cocks as required	Torque pressure That the pressure indicator lamps are extinguished	No further fall in torque pressure is permissible	Stop the engine	(1) With the throttle lever in the fully open position adjust the w/m unit control lever maximum stop clearance by lengthening the w/m unit/cross shaft control rod to cause the w/m injection to cease at a higher r.p.m. (2) Check that the w/m control lever maximum stop clearance is not less than the appropriate clearance given in item (2) of Action C. (3) Re-start the engine and repeat the wet ground run.
H. Close the throttle then let engine conditions stabilize at idling before stopping.				

IN-SERVICE GROUND RUN - DRY

1. Object of ground run

A. To check that at the correct maximum Take-off r.p.m., the turbine gas temperature and torque pressure are within those limits specified for an engine in service.

B. To check that all engine systems are acceptable for service.

2. Action required before commencing in-service ground run

A. Instrumentation and pyrometry

(1) Ensure that the r.p.m. gauge is accurately calibrated.

(2) Ensure that the T.G.T. gauge is accurately calibrated; refer to Chap.77, 'ENGINE INDICATING'.

B. Check the engine r.p.m. and cross-check the aircraft r.p.m. gauge as follows:

(1) Fit the cannon connector on the connecting lead E.R.E.2382, to the r.p.m. 'IN' socket on the front of the r.p.m. digital indicator, E.R.E.2380, refer to Fig.508A.

(2) Remove the electrical plug from the r.p.m. gauge, fitted to the aircraft cockpit instrument panel and connect the plug to the aircraft gauge plug (female) on the connecting lead E.R.E.2382.

(3) Fit the aircraft gauge harness plug (male) to the r.p.m. gauge fitted to the aircraft cockpit instrument panel.

(4) Move the digital indicator switch to 'ON'.

NOTE: The 'Normal' indicator light will illuminate if the indicator battery has an adequate charge.

(5) The indicator is ready for immediate use, but the measuring accuracy will be improved by approximately 0.1 per cent if the indicator is allowed to warm up for 30 minutes.

(6) If the 10 per cent charge indicator light illuminates the indicator can be used for a short period, but it, will require to be re-charged before further prolonged use; refer to Appendix 2.

NOTE: A full charge will allow approximately 8 hours use.

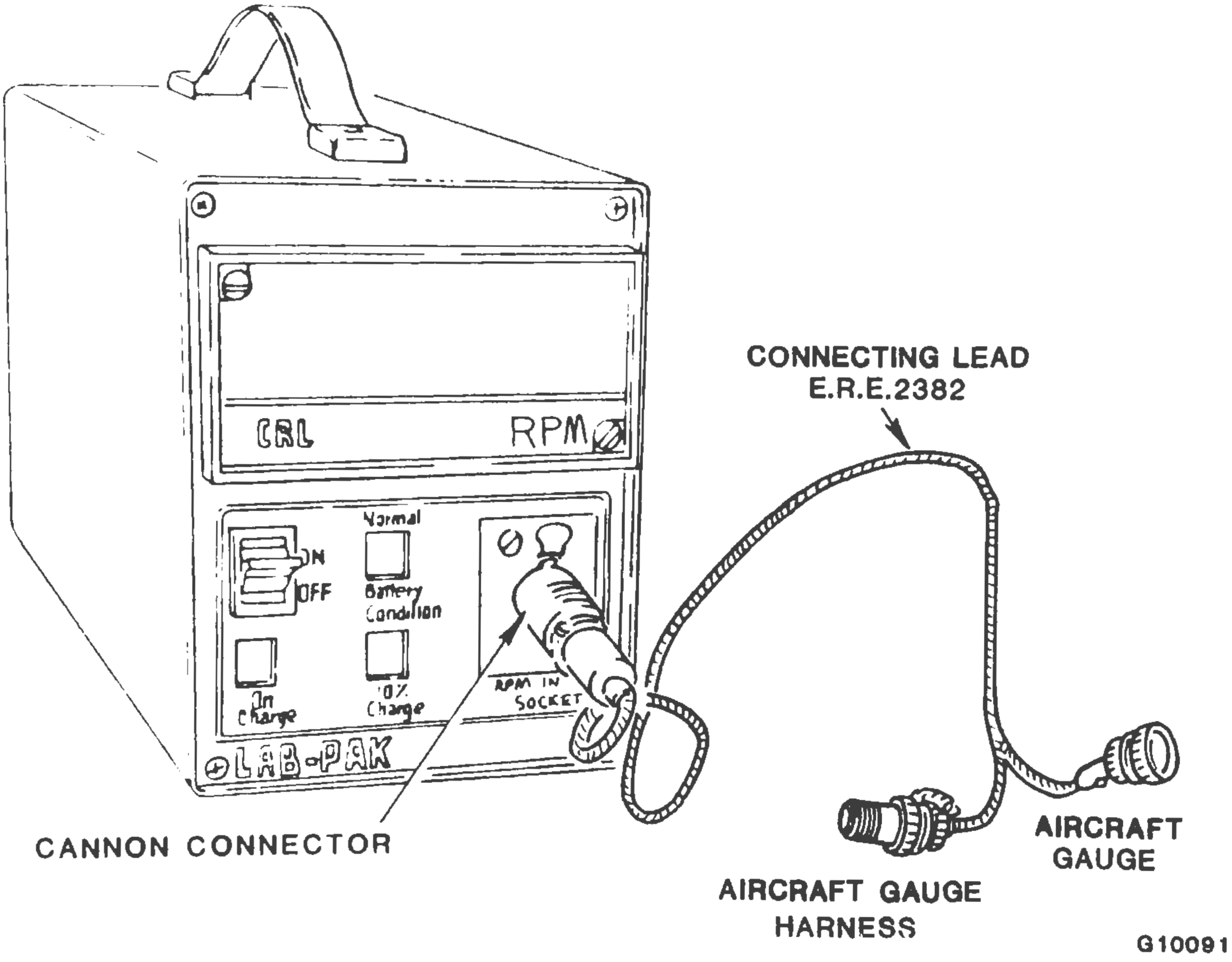
(7) On satisfactory completion of the checks effect the following:

(a) Move the digital indicator switch to 'OFF'.

(b) Disconnect the 2 plugs on the connecting lead, E.R.E.2382, from the aircraft harness lead and the r.p.m. gauge.

(c) Connect the aircraft harness electrical plug to the r.p.m. gauge.

(d) If required, remove the cannon connector from the 'IN' socket of the r.p.m. digital indicator.



R.p.m. digital indicator
Fig.508A

C. Check the engine T.G.T. and cross-check the aircraft T.G.T. gauge as follows:

(1) Pre-Mod.1792 engines

(a) Remove the engine thermocouples main junction box cover.

(b) Pass one end of the 2 metres (6.6 ft.) Chromel/Alumel cable, GZ.39165 or GZ.39165/2, through the aperture of the slave cover, GZ.39166 for pre-Mod.1567 engines or GZ.39167 for Mod.1567 engines.

(c) Fit the brown insulated Chromel lead of the cable under the washers on the setscrew (pre-Mod.1567) or the 4 B.A. nut on the extended setscrew (Mod.1567) which secures the red insulated harness leads to the terminal adjacent to the aircraft extension lead opening in the main junction box. Leave the harness and the aircraft extension leads connected.

(d) Fit the blue insulated Alumel lead of the cable under the washers on the setscrew (pre-Mod.1567) or the 4 B.A. nut on the extended setscrew (Mod.1567) which secures the blue insulated harness leads to the other terminal in the main junction box. Leave the harness and the aircraft extension leads connected.

(e) Fit the slave cover to the main junction box.

(2) Mod.1792 engines

(a) Remove the dust cap from the socket on the aluminium body, mounted on the engine thermocouples main junction box, then connect the 2 metres (6.6 ft.) (Chromel/Alumel cable and plug, GZ.39164 or GZ.39164/2, to the socket.

(3) Using the terminal block, connect the 27 metres (88.6 ft.) Copper/Constantan cable, ERE.2347, to the 2 metres (6.6 ft.) Chromel/Alumel cable, GZ.39165 (pre-Mod.1792) or cable and plug, GZ.39164 (Mod.1792); refer to Fig.508B.

(a) Using the socket supplied with GZ.39164/2 and GZ.39165/2 connect the 27 metres (88.6 ft.) Copper/Constantan cable ERE.2347, to the 2 metres (6.6 ft.) Chromel/Alumel cable GZ.39165/2 (pre-Mod. 1792) or cable and plug GZ.39164/2 (Mod.1792) refer to Fig.508C.

(4) Connect the other end of the Copper/Constantan cable, ERE.2347, to the terminal posts of potentiometer R.R. type GZ.38989 or Foster tye 3154/1883, 3155/DP2163, 3156/DP2163 as follows:

(a) Connect the white insulated copper lead of the cable to the red terminal post of the potentiometer.

(c) Connect the blue insulated constantan lead of the cable to the black terminal post of the potentiometer.

NOTES: (1) The length of the Copper/Constantan cable can be reduced to suit operators requirements.

(2) When using R.R. potentiometer type GZ.38989, the leads can be connected to either set 1 or set 2 terminal posts.

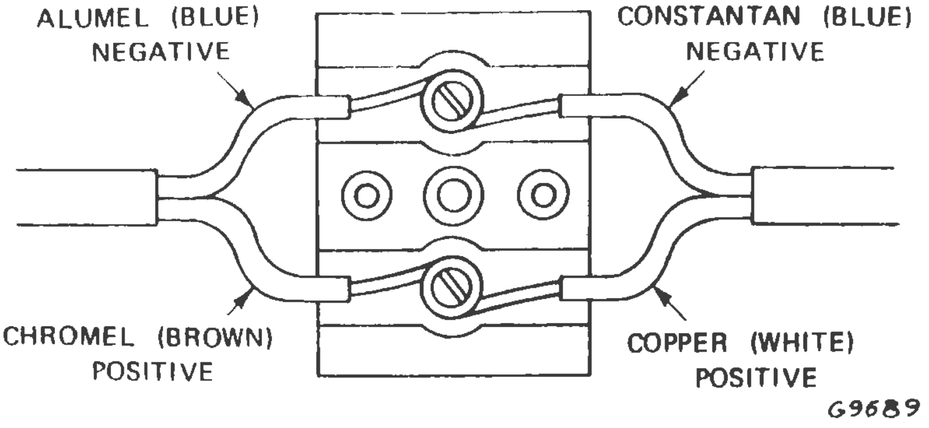
(3) Potentiometers other than those detailed in para.(4) can be used provided they comply with the following:-

(a) Scale range 0-1000 deg.C. Nickel Chromium/Nickel Aluminium BS.4937, Type K.

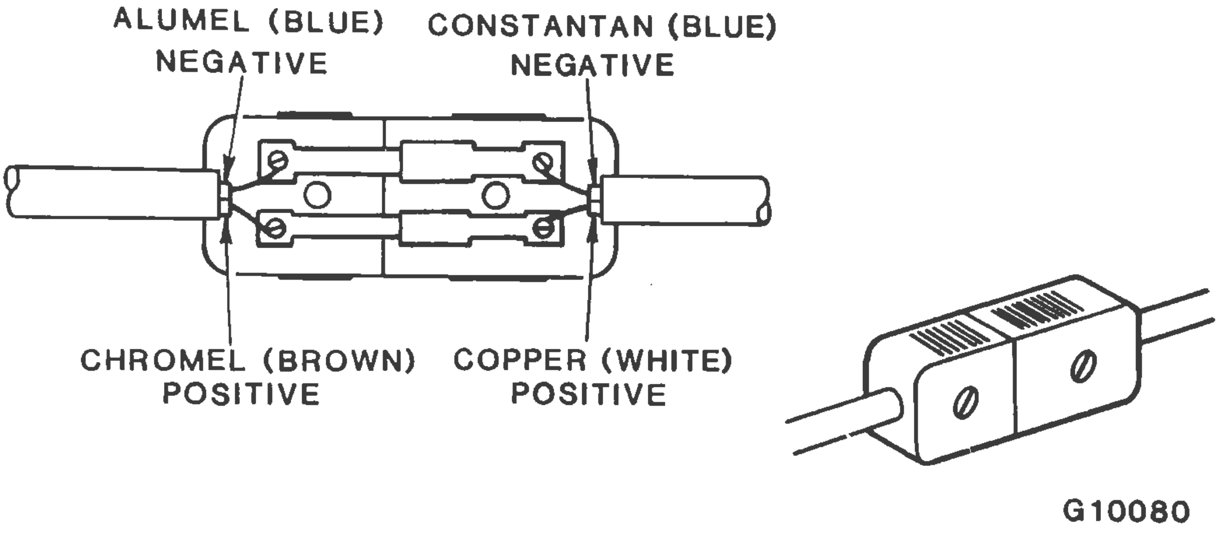
(b) Available millivolt source (60 mV) for calibration of 8 or 25 ohms T.G.T. indicators.

(c) Automatic or manual cold junction temperature compensation.

(d) Instrument accuracy of ± 0.2 per cent of span maximum.



(GZ.39614 and GZ.39615)
Cable leads connected to terminal block
Fig.508B



(GZ.39164/2 and GZ.39165/2)
Cable leads connected to plug assembly
Fig.508C

(c) Position the potentiometer in the place where it will be operated and allow approximately 15 minutes for the carcase temperature to stabilize before taking any readings.

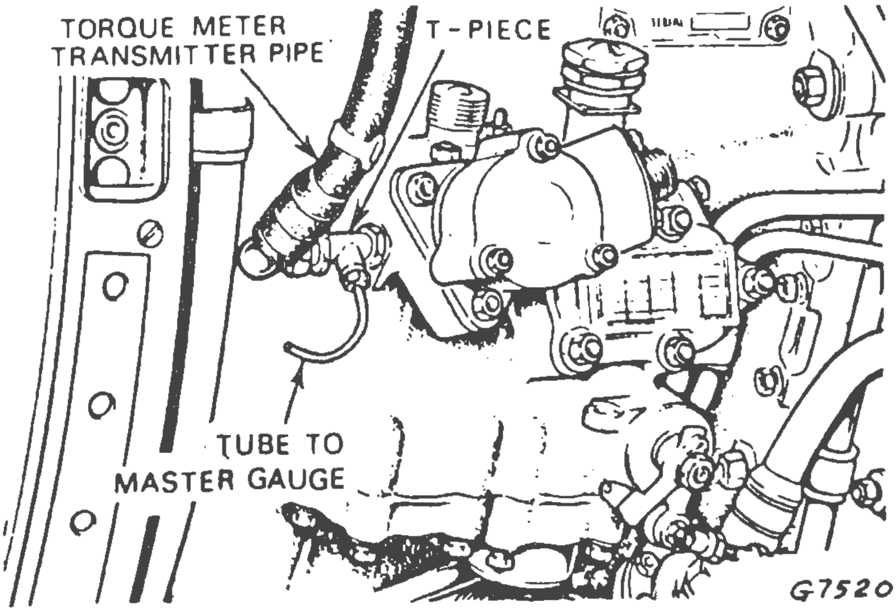
(d) Ensure that the range cap is securely connected on the 60 M.V. socket, and that the potential divider switch is OFF. When using R.R. type GZ.38989, select 60 M.V. on the M.V. switch (situated on the bottom right side of the instrument panel) by moving the switch to the right.

(e) Zero the galvanometer, with button K1 pressed, by rotating the standardising rheostat knob (clockwise moves the needle to the right). On R.R. type GZ.38989 ensure that the galvanometer switch is not in the off position, then push the lever of the MEASURE/STANDARDISE switch to STANDARDISE and zero the galvanometer using the standardising rheostat knob (clockwise moves the needle to the right). If any difficulty is experienced in stabilizing or adjusting the needle, renew the batteries.

(f) Obtain the potentiometer terminal temperature from the mercury thermometer attached to the carcase of the potentiometer, then set this temperature on the cold junction scale (C.J. scale, black numerals).

(g) Set the main temperature scale (0 - 1400 degrees C., black numerals) to approximately the required T.G.T. (this will avoid damage to the galvanometer by excessive deflections when the T.G.T. readings are taken during the ground run).

NOTE: Refer to ACTION 4.D. for the method of operation of the Foster Potentiometer when checking the T.G.T. at maximum take-off conditions.



T-piece adapter - water/methanol control unit
Fig.509

Power plant - Adjustment/test (cont.)

(5) Connect a Bourdon tube type master pressure gauge (GZ.36755/1) between the torquemeter pressure transmitter oil pipe and the connection on the water/methanol control unit, using a T-piece adapter and a suitable length of tubing; refer to Fig.509.

(6) Alternatively, when using torquemeter pressure digital indicator, ERE.2317, connect T-piece adapter, GZ.39107, between the torquemeter transmitter oil pipe and the connection on the water/methanol control unit, then connect transducer, ERE.2320, to the T-piece adapter ensuring that the sealing washer is fitted between the adapter and transducer; refer to Fig.A and Fig.B.

NOTE: The Dowty sealing washer is supplied with the transducer.

(a) Connect the 6 pin Bendix connector on the coupling cable, ERE.2348 to the transducer, then route the cable carefully to the aircraft cockpit and connect the 5 pin Cannon connector on the cable to the socket on the front panel of the digital indicator.

(b) Move the digital indicator switch to 'ON'.

NOTE: The 'Normal' indicator light will illuminate if the indicator battery has adequate charge.

(c) The indicator is ready for immediate use, but measuring accuracy will be improved by approximately 0.1 per cent if the indicator is allowed to warm up for 30 minutes.

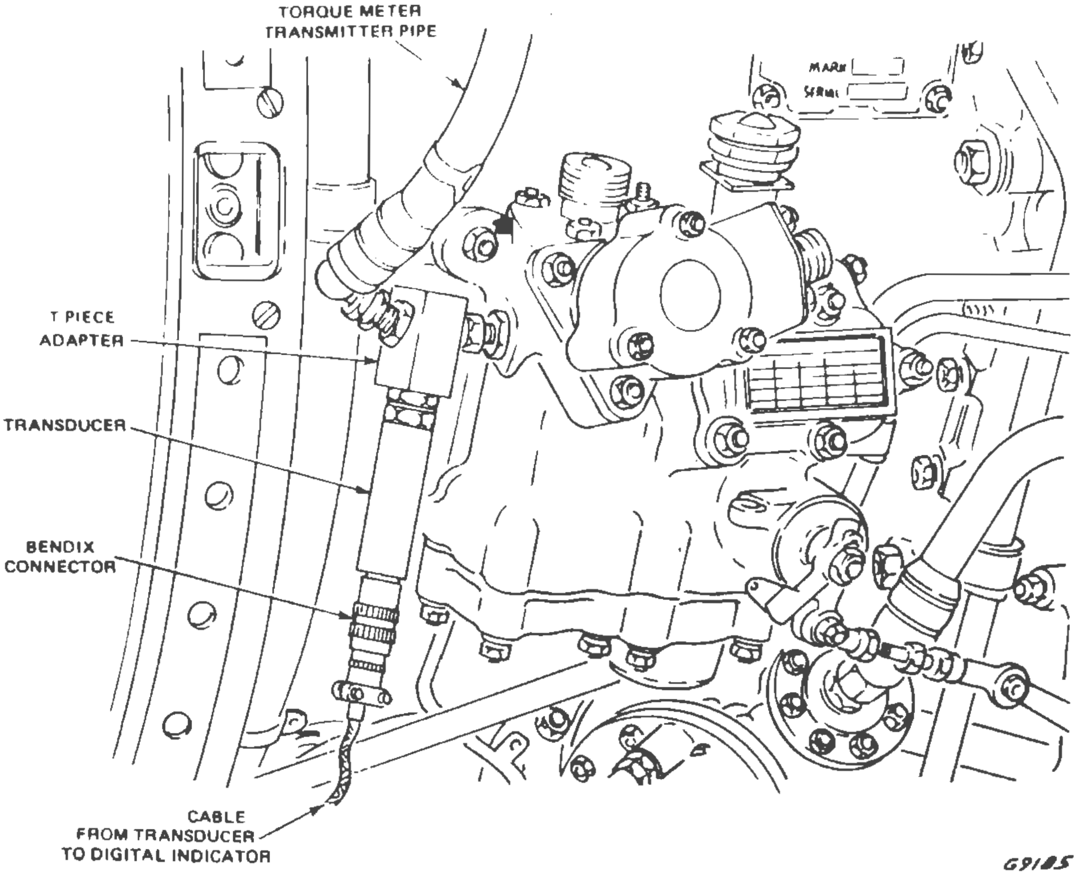
(d) If the '10% Charge' indicator light illuminates the indicator can be used for a short period, but it will require to be re-charged before further prolonged use; refer to Appendix 1, para.3.

NOTE: A full charge will allow approximately 8 hours use.

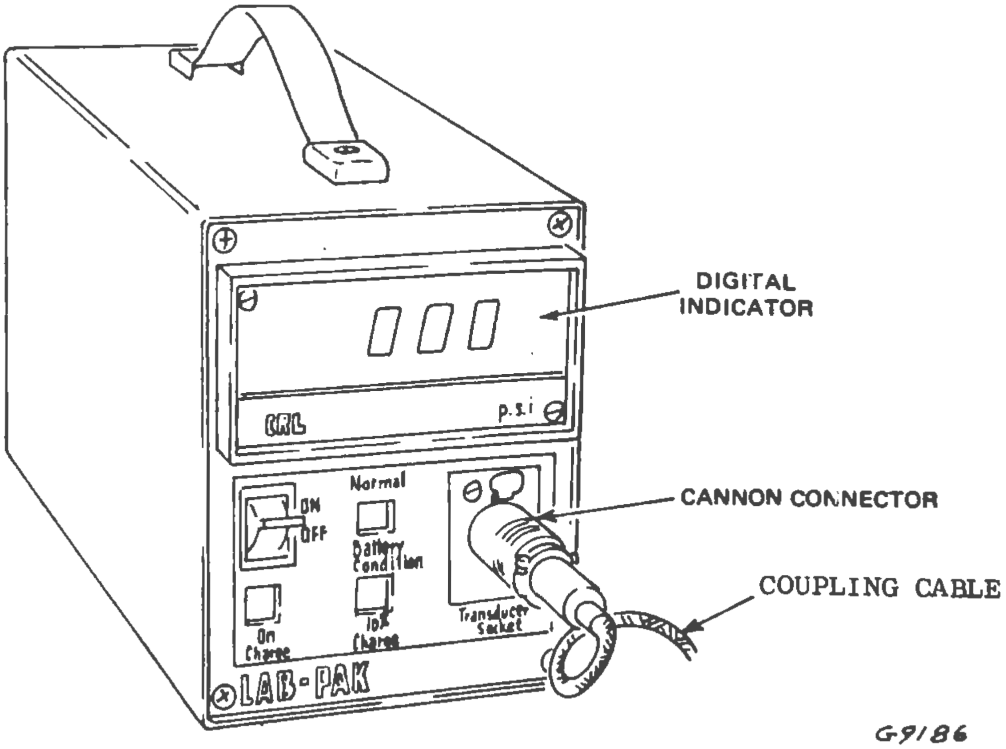
(e) The transducer and digital indicator should be used together as a matched set. If either the transducer or digital indicator have to be replaced (because of a fault) the instrument set should be re-calibrated before further use; refer to Appendix 1, para.2.

(7) On satisfactory completion of the checks remove the equipment fitted at paragraphs (5) or (6).

Power plant - Adjustment/test (cont.)



T-piece adapter and transducer - water/methanol control unit
Fig.A



Torquemeter pressure digital indicator
Fig.B

Power plant - Adjustment/test (cont.)

D. Record the following ambient conditions (refer to para.F.).

(1) Outside air temperature in degrees C. or F.

(a) Suspend a mercury thermometer from a safe position, adjacent to and in the shade of the aircraft, and record the ambient air temperature.

(2) Pressure altitude in feet.

(a) Obtain the prevailing pressure altitude from the aircraft altimeter by setting it to 1013 millibars and reading off the pressure altitude in feet, above or below sea level.

(3) Dew point in degrees C. or F. If the dew point information is not obtainable record the humidity, using a wet and dry bulb thermometer, and convert to the dew point; refer to Sub-section 4E, 'CHARTS'.

NOTE: If the outside air temperature is below 10 degrees C. (50 degrees F.), humidity corrections are not required.

E. Record the following data (refer to para.F.)

(1) Fuel datum trim position for starting; refer to Section 3, 'ENGINE STARTING, MOTORING AND STOPPING DRILLS'.

(2) Fuel datum trim position for the ambient conditions; refer to Sub-section 4E, 'CHARTS'.

(3) Maximum Data-plate Take-off turbine gas temperature corrected for ambient conditions; refer to Sub-section 4E, 'CHARTS'.

(4) 'OPERATING LIMITATION' Take-off turbine gas temperature corrected for ambient conditions; refer to Section 1, 'ENGINE HANDLING' and Sub-section 4E, 'CHARTS'.

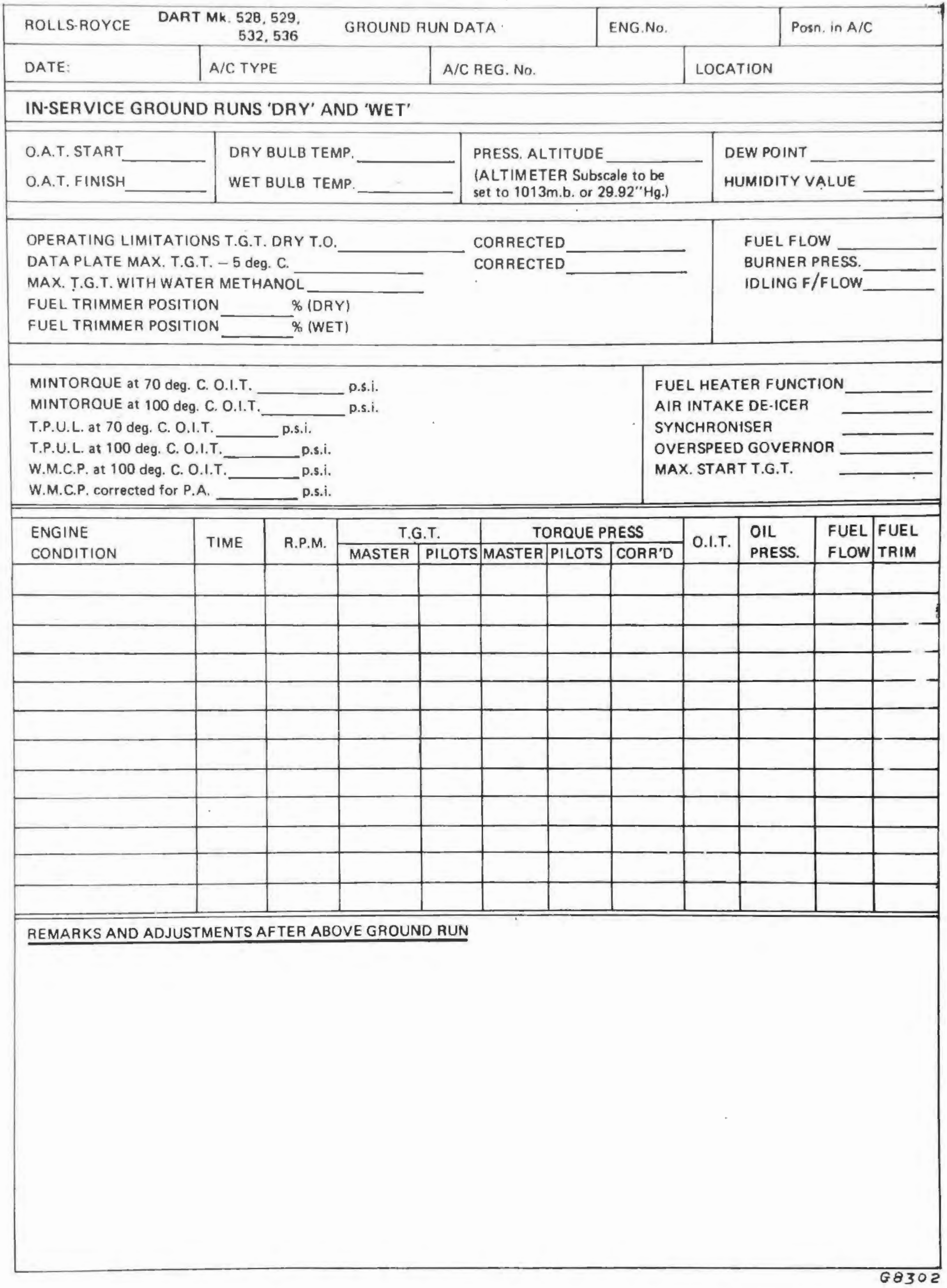
(5) Mintorque values at 70 and 100 degrees C. oil inlet temperature and the oil inlet temperature at which the Mintorque was declared (from the engine log-book or aircraft documents).

(6) Torque pressure upper limit values at 70 and 100 degrees C. oil inlet temperature (from the engine log-book or aircraft documents).

Power plant - Adjustment/test (cont.)

F. Engine ground run pro forma

(1) Fig.509A shows a specimen engine ground run pro forma which may be completed for each ground run, as instructed in para.4. and 5. and retained for record and/or reference purposes.



ROLLS-ROYCE	DART Mk. 528, 529, 532, 536	GROUND RUN DATA	ENG.No.	Posn. in A/C

DATE:	A/C TYPE	A/C REG. No.	LOCATION

IN-SERVICE GROUND RUNS 'DRY' AND 'WET'

O.A.T. START ________
O.A.T. FINISH ________
DRY BULB TEMP. ________
WET BULB TEMP. ________
PRESS. ALTITUDE ________
(ALTIMETER Subscale to be set to 1013m.b. or 29.92"Hg.)
DEW POINT ________
HUMIDITY VALUE ________

OPERATING LIMITATIONS T.G.T. DRY T.O. ________ CORRECTED ________
DATA PLATE MAX. T.G.T. – 5 deg. C. ________ CORRECTED ________
MAX. T.G.T. WITH WATER METHANOL ________
FUEL TRIMMER POSITION ________ % (DRY)
FUEL TRIMMER POSITION ________ % (WET)
FUEL FLOW ________
BURNER PRESS. ________
IDLING F/FLOW ________

MINTORQUE at 70 deg. C. O.I.T. ________ p.s.i.
MINTORQUE at 100 deg. C. O.I.T. ________ p.s.i.
T.P.U.L. at 70 deg. C. O.I.T. ________ p.s.i.
T.P.U.L. at 100 deg. C. O.I.T. ________ p.s.i.
W.M.C.P. at 100 deg. C. O.I.T. ________ p.s.i.
W.M.C.P. corrected for P.A. ________ p.s.i.
FUEL HEATER FUNCTION ________
AIR INTAKE DE-ICER ________
SYNCHRONISER ________
OVERSPEED GOVERNOR ________
MAX. START T.G.T. ________

ENGINE CONDITION	TIME	R.P.M.	T.G.T.		TORQUE PRESS			O.I.T.	OIL PRESS.	FUEL FLOW	FUEL TRIM
			MASTER	PILOTS	MASTER	PILOTS	CORR'D				

REMARKS AND ADJUSTMENTS AFTER ABOVE GROUND RUN

G8302

Specimen engine ground run pro forma
Fig.509A

G. Overspeed governor check

(1) Set the overspeed governor (Chap.73-2, 'FUEL PUMP - MAINTENANCE PRACTICES' 3. Adjustment/test, para.A.) prior to an 'In-Service' ground run, only if required by the approved inspection period.

3. Abbreviations

Wherever possible, abbreviations have been avoided, however, because of space restrictions some abbreviations have been used in the tables and illustrations. Listed below are the abbreviations and their definitions.

C.	Centigrade
E.P.C.P.	engine power check pressure
F.	Fahrenheit
F.C.U.	fuel control unit
F.F.P.S.	flight fine pitch stop
ft.	feet
G.P.C.P.	ground power check pressure
I.S.A.	International standard atmosphere
Max.	maximum
Mk.	Mark
Min.	minimum
Mod.	modification
O.A.T.	outside air temperature
O.I.T.	oil inlet temperature
P.A.	pressure altitude
P.C.U.	propeller controller unit
p.s.i.	pounds per square inch
r.p.m.	revolutions per minute
S.B.	Service Bulletin
S.H.P.	shaft horse-power
S.L.	sea level
T.O.	Take-off
T.P.U.L.	Torque pressure upper limit
T.V.	throttle valve
T.G.T.	turbine gas temperature
w/m	water/methanol
W.M.C.P.	water/methanol check pressure
W.M.C.U.	water/methanol control unit

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JT
A
DG

IN-SERVICE GROUND RUN - DRY

1. Object of ground run

A. To check that at the correct maximum Take-off r.p.m. the turbine gas temperature and torque pressure are within those limits specified for an engine in service.

B. To check that all engine systems are acceptable for service.

2. Action required before commencing in-service ground run

A. Instrumentation and pyrometry

(1) Ensure that the r.p.m. gauge is accurately calibrated.

(2) Ensure that the engine and the associated aircraft pyrometry systems are fully serviceable and that the T.G.T. gauge is accurately calibrated; refer to Chap.77 'ENGINE INDICATING'.

(3) To check the T.G.T. and cross-check the aircraft T.G.T. gauge connect a Foster Potentiometer, type 3154/1883, 3155/DP, 3156/DP or Potentiometer R.R. type GZ.38989 to the aircraft T.G.T. cable terminals in the engine thermocouples main junction box (leave the aircraft T.G.T. cable terminals connected) using a suitable length of Chromel/ Alumel or Copper/Constantan cable; on R.R. type GZ.38989 either No.1 or No.2 input terminals may be used. Ensure that correct polarity is maintained; the Alumel cable and the Constantan cable are magnetic (NEGATIVE).

NOTE: Sixty feet of cable (ERE.2255) will allow the potentiometer to be operated in the crew compartment. The cable length can be adjusted to suit the particular installation.

(a) Position the potentiometer in the place where it will be operated , for approximately 15 minutes , before any readings are taken; this will allow the carcase temperature of the potentiometer to stabilise.

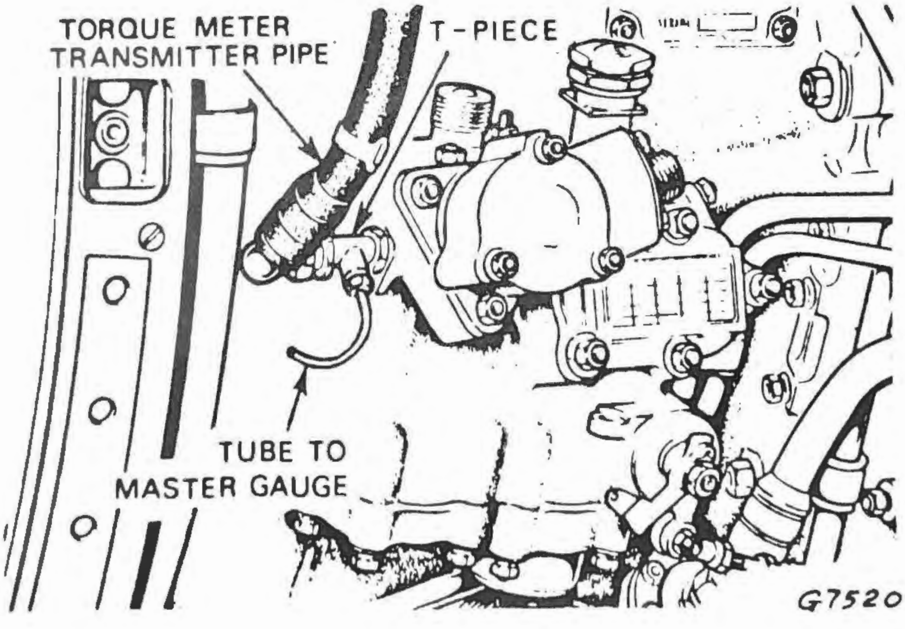
(b) Ensure that the range cap is securely connected on the 60 M.V. socket, and that the potential divider switch is OFF. When using R.R. type GZ.38989, select 60 M.V. on the M.V. switch (situated on the bottom right side of the instrument panel) by moving the switch to the right.

(c) Zero the galvanometer, with button K1 pressed, by rotating the standardising rheostat knob (clockwise moves the needle to the right). On R.R. type GZ.38989 ensure that the galvanometer switch is not in the off position, then push the lever of the MEASURE/STANDARDISE switch to STANDARDISE and zero the galvanometer using the standardising rheostat knob (clockwise moves the needle to the right). If any difficulty is experienced in stabilising or adjusting the needle, renew the batteries.

(d) Obtain the potentiometer terminal temperature from the mercury thermometer attached to the carcase of the potentiometer, then set this temperature on the cold junction scale (C.J. scale, black numerals).

(e) Set the main temperature scale (0 - 1400 degrees C., black numerals) to approximately the required T.G.T. (this will avoid damage to the galvanometer by excessive deflections when the T.G.T. readings are taken during the ground run).

NOTE: Refer to ACTION 4.D. for the method of operation of the Foster Potentiometer when checking the T.G.T. at maximum Take-off conditions.



T-piece adapter - water/methanol control unit
Fig.509

Power plant - Adjustment/test (cont.)

(4) Connect a Bourdon tube type master pressure gauge (GZ.36755) between the torque pressure transmitter oil pipe and the connection on the water/methanol control unit, using a T-piece adapter and a suitable length of tubing (Fig.509).

B. Record the following ambient conditions (refer to para.D.).

(1) Outside air temperature in degrees C. or F.

(a) Suspend a mercury thermometer from a safe position, adjacent to and in the shade of the aircraft, and record the ambient air temperature.

(2) Pressure altitude in feet.

(a) Obtain the prevailing pressure altitude from the aircraft altimeter by setting it to 1013 millibars and reading off the pressure altitude in feet, above or below sea level.

(3) Dew point in degrees C. or F. If the dew point information is not obtainable record the humidity, using a wet and dry bulb thermometer, and convert to the dew point; refer to Sub-section 4E, 'CHARTS'.

NOTE: If the outside air temperature is below 10 degrees C. (50 degrees F.), humidity corrections are not required.

C. Record the following data (refer to para.D.)

(1) Fuel datum trim position for starting; refer to Section 3, 'ENGINE STARTING, MOTORING AND STOPPING DRILLS'.

(2) Fuel datum trim position for the ambient conditions; refer to Sub-section 4E, 'CHARTS'.

(3) Maximum Data-plate Take-off turbine gas temperature corrected for ambient conditions; refer to Sub-section 4E, 'CHARTS'.

(4) 'OPERATING LIMITATION' Take-off turbine gas temperature corrected for ambient conditions; refer to Section 1, 'ENGINE HANDLING' and Sub-section 4E, 'CHARTS'.

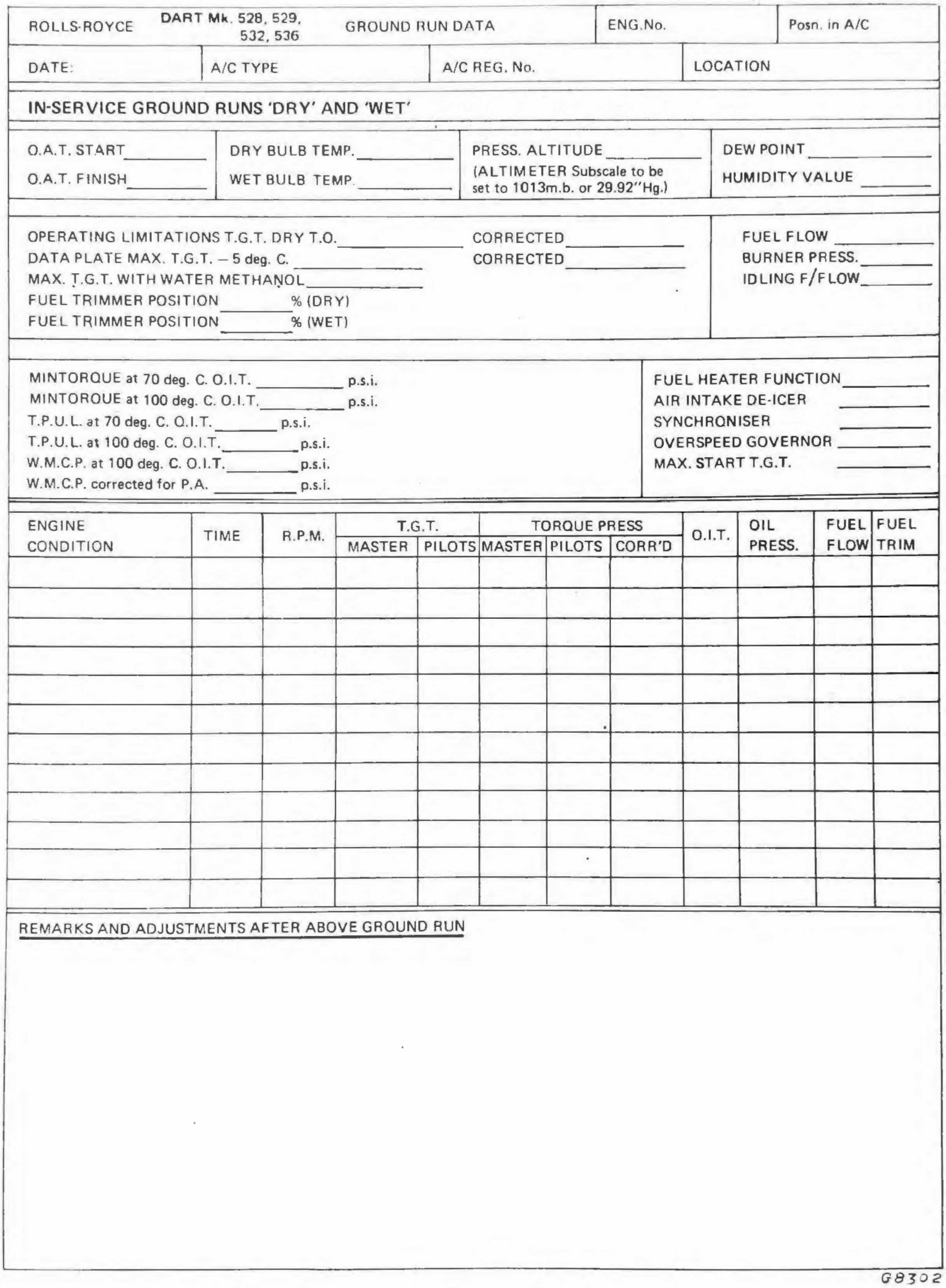
(5) Mintorque values at 70 and 100 degrees C. oil inlet temperature and the oil inlet temperature at which the Mintorque was declared (from the engine log-book or aircraft documents).

(6) Torque pressure upper limit values at 70 and 100 degrees C. oil inlet temperature (from the engine log-book or aircraft documents).

Power plant - Adjustment/test (cont.)

D. Engine ground run pro forma

(1) Fig.509A shows a specimen engine ground run pro forma which may be completed for each ground run, as instructed in para.4. and 5. and retained for record and/or reference purposes.



ROLLS-ROYCE	DART Mk. 528, 529, 532, 536	GROUND RUN DATA	ENG.No.	Posn. in A/C

DATE:	A/C TYPE	A/C REG. No.	LOCATION

IN-SERVICE GROUND RUNS 'DRY' AND 'WET'

O.A.T. START ________
O.A.T. FINISH ________
DRY BULB TEMP. ________
WET BULB TEMP. ________
PRESS. ALTITUDE ________
(ALTIMETER Subscale to be set to 1013m.b. or 29.92"Hg.)
DEW POINT ________
HUMIDITY VALUE ________

OPERATING LIMITATIONS T.G.T. DRY T.O. ________ CORRECTED ________
DATA PLATE MAX. T.G.T. – 5 deg. C. ________ CORRECTED ________
MAX. T.G.T. WITH WATER METHANOL ________
FUEL TRIMMER POSITION ________ % (DRY)
FUEL TRIMMER POSITION ________ % (WET)
FUEL FLOW ________
BURNER PRESS. ________
IDLING F/FLOW ________

MINTORQUE at 70 deg. C. O.I.T. ________ p.s.i.
MINTORQUE at 100 deg. C. O.I.T. ________ p.s.i.
T.P.U.L. at 70 deg. C. O.I.T. ________ p.s.i.
T.P.U.L. at 100 deg. C. O.I.T. ________ p.s.i.
W.M.C.P. at 100 deg. C. O.I.T. ________ p.s.i.
W.M.C.P. corrected for P.A. ________ p.s.i.
FUEL HEATER FUNCTION ________
AIR INTAKE DE-ICER ________
SYNCHRONISER ________
OVERSPEED GOVERNOR ________
MAX. START T.G.T. ________

ENGINE CONDITION	TIME	R.P.M.	T.G.T.		TORQUE PRESS			O.I.T.	OIL PRESS.	FUEL FLOW	FUEL TRIM
			MASTER	PILOTS	MASTER	PILOTS	CORR'D				

REMARKS AND ADJUSTMENTS AFTER ABOVE GROUND RUN

G8302

Specimen engine ground run pro forma
Fig.509A

E. Overspeed governor check

(1) Set the overspeed governor (Chap.73-2, 'FUEL PUMP - MAINTENANCE PRACTICES' 3. Adjustment/test, para.A.) prior to an 'In-Service' ground run, only if required by the approved inspection period.

3. Abbreviations

Wherever possible, abbreviations have been avoided, however, because of space restrictions some abbreviations have been used in the tables and illustrations. Listed below are the abbreviations and their definitions.

C.	Centigrade
E.P.C.P.	engine power check pressure
F.	Fahrenheit
F.C.U.	fuel control unit
F.F.P.S.	flight fine pitch stop
ft.	feet
G.P.C.P.	ground power check pressure
I.S.A.	International standard atmosphere
Max.	maximum
Mk.	Mark
Min.	minimum
Mod.	modification
O.A.T.	outside air temperature
O.I.T.	oil inlet temperature
P.A.	pressure altitude
P.C.U.	propeller controller unit
p.s.i.	pounds per square inch
r.p.m.	revolutions per minute
S.B.	Service Bulletin
S.H.P.	shaft horse-power
S.L.	sea level
T.O.	Take-off
T.P.U.L.	Torque pressure upper limit
T.V.	throttle valve
T.G.T.	turbine gas temperature
w/m	water/methanol
W.M.C.P.	water/methanol check pressure
W.M.C.U.	water/methanol control unit

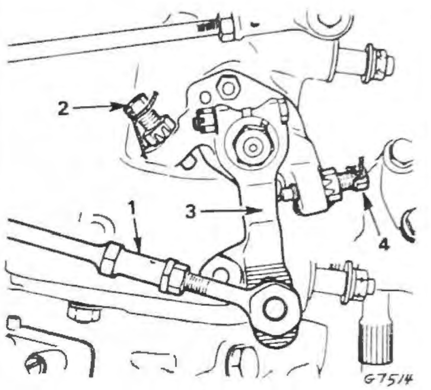
Power plant - Adjustment/test (cont.)

TABLE 4

4. Ground run sequence

ACTION	CHECK	ACCEPTANCE LIMITS	ACTION IF INCORRECT	RECTIFICATION, CALCULATION AND ILLUSTRATIONS
NOTE: Actions A. B. and D. are for checking the engine interconnection; action C. is for function checking the hot-air valve.				
A. Set the FUEL DATUM; start the engine as instructed in Section 3, 'ENGINE STARTING, MOTORING AND STOPPING DRILLS'	Oil pressure	Needle off the stop	Stop the engine	Refer to 'POWER PLANT - TROUBLE SHOOTING', Oil system defects (page block 101).
	T.G.T. during start	Maximum: 930 degrees C.	Stop the engine	Refer to 'POWER PLANT - TROUBLE SHOOTING', Engine starting faults (page block 101).
	T.G.T. when stabilized	Maximum: 550 degrees C.	Stop the engine	Refer to 'POWER PLANT - TROUBLE SHOOTING', Engine starting faults (page block 101).
	Oil inlet temperature	Minimum: minus 15 degrees C.	Run engine at up to 11,000 r.p.m. to achieve the required minimum temperature	
B. Set the FUEL DATUM for ambient conditions as appropriate to engine Mk. and modification standard; refer to Sub-section 4E 'CHARTS'.				
C. Set the throttle to obtain 10,000 r.p.m. approximately	Immediately the throttle is moved check the low oil pressure warning light	Light is extinguished when the oil pressure reaches 5 to 6 p.s.i.	Stop the engine	Refer to 'POWER PLANT - TROUBLE SHOOTING', Oil system defects (page block 101).
	Oil pressure	Steady increase	Stop the engine	Refer to 'POWER PLANT - TROUBLE SHOOTING', Oil system defects, (page block 101).
(1) 2-position valve or 3-position valve (Mod.1397) with half heat unused Mod.1434):	Hot air valve (fuel heater)			
Switch fuel heater ON		Small reduction in r.p.m. (approximately 50 r.p.m.)	Feel for hot air discharge from heater	Refer to Chapter 75-1-1 'MAINTENANCE PRACTICES - HOT AIR VALVE'
Switch fuel heater OFF		R.p.m. restored to original value	Feel that discharge has ceased entirely	

TABLE 4 (cont.)

ACTION	CHECK	ACCEPTANCE LIMITS	ACTION IF INCORRECT	RECTIFICATION, CALCULATION AND ILLUSTRATIONS
C. (cont.)				
(2) 3-position valve (Mod.1397)				
Switch fuel heater ON.				
Select HALF heat		Small reduction in r.p.m. (approximately 50 r.p.m.)	Feel for warm air discharge from heater	Refer to Chapter 75-1-1 'MAINTENANCE PRACTICES - HOT AIR VALVE'
Select FULL heat		Further small reduction in r.p.m. (approximately 50 r.p.m.)	Feel for hot air discharge from heater	
Switch fuel heater OFF		R.p.m. restored to original value	Feel that discharge has ceased entirely	
NOTES: (1) Since oil inlet temperature increases with time at full throttle, the checks in ACTION D are listed in sequence of increasing oil inlet temperature. (2) Ensure that unnecessary electrical load is switched off and that cabin compressors are unloaded				 R.p.m. control lever and stops Fig.509B
D. Open the throttle fully	R.p.m.	Minimum: 15,000 r.p.m. Maximum: 15,050 r.p.m.	Stop the engine	(1) Refer to 'POWER PLANT - TROUBLE SHOOTING', R.p.m. faults (page block 101) (2) If the error exceeds 400 r.p.m. do not attempt to reset the engine r.p.m. before checking instrumentation and propeller equipment. (3) Adjust the rod length (1) between the propeller control unit r.p.m. control lever (3) and the cross shaft lever (Fig.509B). NOTE: One turn of the rod (1) clockwise (viewed from the rear of the engine) should increase the maximum engine r.p.m. by 200 approximately. (4) Open and shut the pilot's throttle lever fully and check that propeller control unit r.p.m. control lever (3) is at least 0.050 in. clear of the maximum and minimum stops (4) and (2); adjust the stops as necessary.
	Oil inlet temperature	Minimum: 65 degrees C. Maximum: 75 degrees C.	If below 65 degrees C. continue run until this temperature is achieved; if above 75 degrees C. run at idle until below this temperature	
	Oil pressure; record observed pressure	Normal: 12 to 35 p.s.i.	Stop the engine	Refer to 'POWER PLANT - TROUBLE SHOOTING', Oil system defects' (page block 101).

D. Turbine gas temperature (cont.) * * *

(1) Use Foster Potentiometer, types 3154/1883, 3155/DP or 3156/DP; refer to para.2.A. (3)(a) to (e).

(a) Press button K2 and zero the galvanometer by rotating the main scale knob (clockwise moves the needle to the right).

(b) When the galvanometer has no deflections, with button K2 pressed, the T.G.T. reading is stabilised and can be read from the potentiometer main scale and the aircraft T.G.T. gauge.

(c) It is essential to repeat the instructions in para.2.A.(3)(c) and (d) at regular intervals to ensure that the galvanometer remains zeroed.

(2) Use Potentiometer R.R. type GZ.38989; refer to para.2.A.(3)(a) to (e).

(a) Select 1 or 2 on the left-hand rotary switch, depending on the input terminals being used.

(b) Select the OFF position on the right-hand rotary switch.

(c) Push the lever of the MEASURE/STANDARDISE switch to MEASURE and zero the galvanometer, using the main scale adjustment knob (clockwise moves the needle to the right).

(d) When the galvanometer has no deflections, with MEASURE selected, the T.G.T. reading is stabilised and can be read from the potentiometer main scale and the aircraft T.G.T. gauge.

(e) It is essential to repeat the instructions in para.2.A.(3)(c) and (d) at regular intervals to ensure that the galvanometer remains zeroed.

TABLE 4 (cont.)

ACTION	CHECK	ACCEPTANCE LIMITS	ACTION IF INCORRECT	RECTIFICATION, CALCULATIONS AND ILLUSTRATIONS
D. (cont.)	NOTE: When checking the torque pressure the O.I.T. should be as near as possible to the O.I.T. at which the mintorque was obtained during the installation ground run.			
Continue running engine at full throttle for a minimum of 4 minutes	Torque pressure; record observed pressure shown on aircraft and master torque pressure gauge; refer to para.2.A.(4). Record T.G.T.	Refer to 5. 'Check the torque pressure limits' NOTE: This instruction is located immediately following TABLE 4		
	Oil inlet temperature and record same	Min. 85 degrees C. Max. 100 degrees C.	Refer to Section 4, 'ENGINE GROUND RUNNING PROCEDURES', para.8.C.	
If necessary, continue running engine at full throttle until T.G.T. has stabilized Min. 4 minutes Max. 5 minutes	Turbine gas * temperature * *	Between the corrected OPERATING LIMITATIONS for TAKE-OFF T.G.T. without water/methanol (refer to Section 1, 'ENGINE HANDLING') and corrected DATA-PLATE TAKE-OFF MAX. T.G.T. minus 5 degrees C. Refer to Sub-section 4E, 'CHARTS' for T.G.T. corrections	Stop the engine Re-set the controls to obtain the correct T.G.T. then re-start the ground run at the commencement of Action D. NOTE: Ensure that oil inlet temperature is below 70 degrees C. before re-commencing ground run.	Refer to 'POWER PLANT - TROUBLE SHOOTING', T.G.T. faults (page block 101). Refer to para.6., Re-set the engine controls
	Oil inlet temperature	120 degrees C. MAXIMUM		

TABLE 4 (cont.)

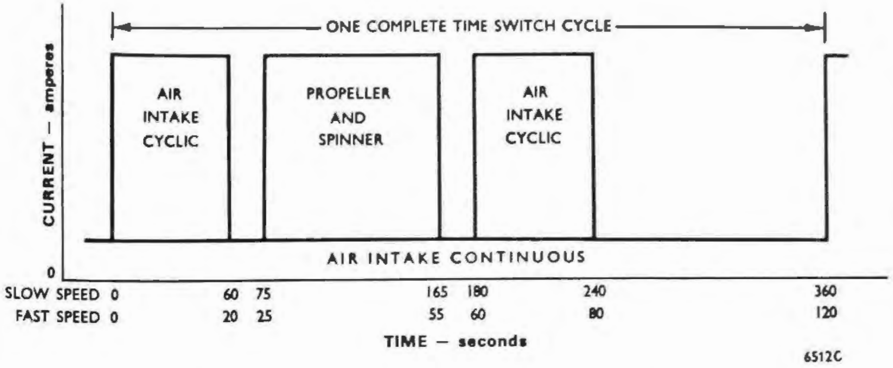
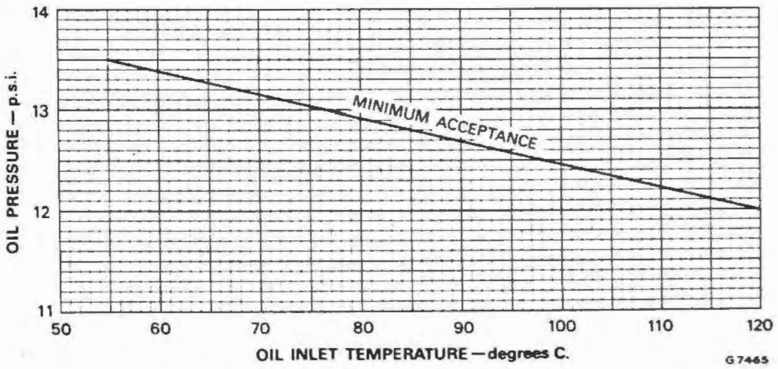
ACTION	CHECK	ACCEPTANCE LIMITS	ACTION IF INCORRECT	RECTIFICATION, CALCULATIONS AND ILLUSTRATIONS
NOTE: Action E.(1) is to check, if required, the power unit ice protection system; action E.(2) is to check the oil pressure.				
E. (1) Set the throttle to obtain 12,800 r.p.m.	Power unit ice protection system (only if required)	Refer to Fig.510	Refer to Chapter 30, 'ICE AND RAIN PROTECTION'	 ONE COMPLETE TIME SWITCH CYCLE AIR INTAKE CYCLIC PROPELLER AND SPINNER AIR INTAKE CYCLIC AIR INTAKE CONTINUOUS CURRENT — amperes 0 SLOW SPEED 0 60 75 165 180 240 360 FAST SPEED 0 20 25 55 60 80 120 TIME — seconds 6512C Power unit ice protection system switch sequence Fig.510
(2) Set the throttle to obtain 12,000 r.p.m.	Oil inlet temperature	Minimum: 55 degrees C. Maximum: 120 degrees C.	Run to warm up	
	Oil pressure	Minimum: 13½ p.s.i. at 55 degrees C. and pro-rata down to 12 p.s.i. at 120 degrees C. and above; refer to Fig.511 Maximum: 35 p.s.i. at any temperature If oil pressure is below minimum, run at maximum continuous r.p.m.; accept engine if oil pressure is not less than 13½ p.s.i. at 55 degrees C. and pro-rata down to 12 p.s.i. at 120 degrees C.	Stop the engine	Refer to 'POWER PLANT - TROUBLE SHOOTING', oil system defects (page block 101)  Minimum oil pressure limitation graph Fig.511

TABLE 4 (cont.)

ACTION	CHECK	ACCEPTANCE LIMITS	ACTION IF INCORRECT	RECTIFICATION, CALCULATIONS AND ILLUSTRATIONS
NOTE: Actions F. and G. are for checking the minimum constant speeding r.p.m. and the ground idling r.p.m.				
F. Set the FUEL DATUM to 50 per cent. Set the throttle to obtain 50 p.s.i. torque pressure, then vary the FUEL DATUM between 30 per cent and 70 per cent.	Minimum constant speeding r.p.m. (minimum governed speed)	R.p.m. must remain constant and must be within the following limits: 10,850 and 11,150 r.p.m.	Stop the engine	Chap.61, 'PROPELLER UNIT - MAINTENANCE PRACTICES'.
G. Close the throttle and set the FUEL DATUM as follows: For Mk.536-7P and 536-7R engines, 85 per cent. For all other engine Mks., 100 per cent	Ground idling r.p.m.	Between 6,500 and 7,500 r.p.m.	Stop the engine	Refer to 'POWER PLANT - TROUBLE SHOOTING', r.p.m. faults (page block 101).
H. Close the throttle and let engine conditions stabilize at idling r.p.m. before stopping the engine. If necessary carry out a wet ground run; refer to Sub-section 4 B, 'GROUND RUN - WET'.				

5. Check the torque pressure limits

A. Correct the observed torque pressure to I.S.A. S.L. value.

(1) Mk.528, 532, 536 and variants.

(a) For pressure altitudes of 3,000 feet or less, refer to Fig.522, Sub-section 4E 'CHARTS'.

(b) For pressure altitudes of 3,000 feet to 10,000 feet, refer to Fig.524, Sub-section 4E 'CHARTS'.

(2) Mk.529 and variants.

(a) For pressure altitudes of 3,000 feet or less, refer to Fig.523, Sub-section 4E 'CHARTS'.

(b) For pressure altitudes of 3,000 feet to 10,000 feet, refer to Fig.525, Sub-section 4E 'CHARTS'.

(3) Mk.532-7P and 536-7P only.

(a) For pressure altitudes of 10,000 to 15,000 feet, refer to Fig.526, Sub-section 4E 'CHARTS'.

(4) If the outside air temperature is below 10 degrees C. a humidity correction is not required. If the outside air temperature is above 10 degrees C. obtain a humidity correction as follows.

(a) To obtain a humidity correction factor from graph E (Fig.522 to 526, Sub-section 4E 'CHARTS') read from the dew point scale to the required pressure altitude, then across to the left hand axis. Show the resultant humidity correction factor as a short line at the correct value parallel to the existing humidity correction lines already drawn on graph B.

(5) To correct the observed torque pressure use the recorded ambient conditions the observed torque pressure and the oil inlet temperature; refer to Fig.522 to 526, Sub-section 4E 'CHARTS'.

(a) Start at graph A, read from the outside air temperature scale to the required pressure altitude, then across to graph B to the humidity correction factor obtained in para.(4)(a). When a humidity correction factor is not required read to the zero humidity correction line.

(b) Read down from graph B to the observed pressure value on graph C; read across from this value to the left hand vertical axis of graph D to obtain the corrected torque pressure; record this figure.

NOTE: The value of each small square on the left-hand vertical axis of graph D is 4 p.s.i.

B. Plot the corrected torque pressure.

(1) Produce a graph similar to graph D on Fig.522 to 526, Sub-section 4E 'CHARTS' (do not include the lines shown only for example).

(2) On the prepared graph (using the previously recorded torque figures) mark the Mintorque and the torque pressure upper limit lines for 70 degrees C. oil inlet temperature on the left hand vertical axis and the Mintorque and torque pressure upper limit lines for 100 degrees C. oil inlet temperature on the right hand vertical axis.

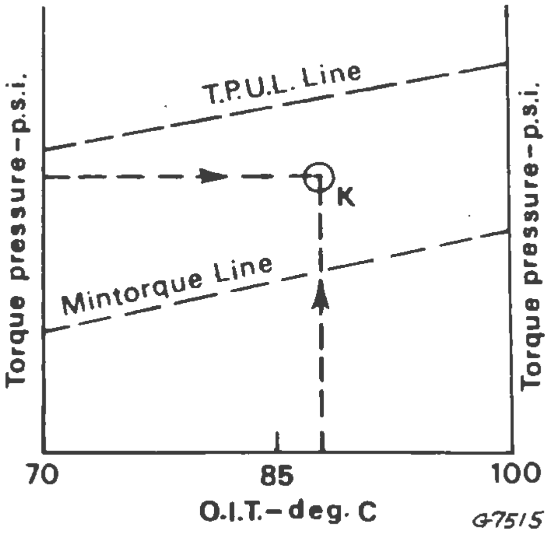
(3) Join the respective points to produce lines similar to those illustrated in the example (Fig.512).

(4) If an engine has Mintorque values declared but no torque pressure upper limit line values, proceed as follows:

(a) Subtract the Data-plate minimum turbine gas temperature from the Data-plate maximum turbine gas temperature and add 15 to the resultant value.

(Data-plate maximum T.G.T. - Data-plate minimum T.G.T.) + 15

NOTE: For the purpose of this calculation one degree C. of turbine gas temperature is equivalent to one p.s.i. of torque pressure.



Example of use of graph D
Fig.512

(b) Add the value obtained in para.(a) to the Mintorque values already recorded at 70 and 100 degrees C. oil inlet temperature to obtain the reference torque pressure upper limit values.

(c) Record in the engine log-book and appropriate aircraft documents the torque pressure upper limit values at 70 and 100 degrees C. oil inlet temperature.

(5) Draw a horizontal line from the point on the left-hand vertical axis corresponding to the corrected torque pressure. Draw a vertical line from the point on the horizontal axis at the oil inlet temperature observed when the torque pressure was recorded during the ground run. Call the point of intersection 'K' (Fig.512).

C. Acceptance limits

(1) If 'K' lies between the Mintorque line and the torque pressure upper limit line the engine is acceptable for service; if not, apply the corrective actions given in D. and E.

CAUTION: DO NOT REDUCE THE FUEL FLOW IN ORDER TO BRING TORQUE PRESSURE BELOW THE TORQUE PRESSURE UPPER LIMIT LINE; REFER TO 'TROUBLE SHOOTING', PAGE BLOCK 101.

NOTE: Fuel flow may only be reduced in service to keep the dry Take-off turbine gas temperature within the maximum operating limit.

D. Low torque pressure engines.

(1) Refer to 'POWER PLANT - TROUBLE SHOOTING', torque pressure defects (page block 101).

E. High torque pressure engines.

(1) Refer to 'POWER PLANT - TROUBLE SHOOTING', torque pressure defects (page block 101).

6. Re-set the engine controls (Fig.513)

NOTE: To ensure consistent results always set the fuel datum position indicator from a lower value.

A. Re-set the controls if there is sufficient adjustment on the control box adjustable stop.

(1) Re-set the controls to obtain the required turbine gas temperature.

(a) Open the pilot's throttle lever fully and set the FUEL DATUM position indicator to FULL INCREASE (100 per cent) for all engine Mks.

(b) Adjust the rod length (5) between the throttle valve lever (2) and the engine control box to obtain the required turbine gas temperature, adjusting the fuel control unit maximum stop (1) to obtain not less than 0.050 in. clearance.

NOTE: One sixth of a turn of the rod (5) anti-clockwise (viewed from the rear of the engine) increases the turbine gas temperature approximately 3 degrees C.

(c) Close the pilots' throttle lever fully and set the FUEL DATUM position indicator to:

Mk.536-7P, 536-7R and 535-7 - 85 per cent
All other Mks. - 100 per cent

(d) Adjust the engine control box adjustable stop (8), (with the throttle pick-up lever (6),contacting it) to obtain a clearance between the throttle valve lever (2) and the fuel control unit minimum stop (3) of:

Modification standard	Minimum stop (3) clearance	Adjustable stop (8) projection limits
Pre-Mod.1138	0.100 in.	0.0 in. to 0.100 in.
Mod.1138 (S.B.Da72-151) but pre-Mod.1523	0.120 in.	0.0 in. to 0.175 in.
Mod.1523 (S.B.Da73-55)	0.140 in.	0.0 in. to 0.225 in.

(2) If permissible adjustment is insufficient, re-set the throttle valve lever as instructed in para.B.

B. Re-set the controls if there is insufficient adjustment on the control box adjustable stop

(1) Set a datum position for maximum Take-off fuel flow.

(a) Open the pilot's throttle lever fully and set the FUEL DATUM position indicator to:

Mk.536-7P, 536-7R and 535-7	-	85 per cent
All other Mks.	-	100 per cent

(b) To provide the datum position, adjust the fuel control unit maximum stop (1) to just contact the throttle valve lever (2) ensuring that the throttle pick-up lever (6) contacts the engine control box maximum stop (7).

(2) Re-set the controls box adjustable stop to mid-travel.

(a) Set the controls box adjustable stop (8) projection to:

Pre-Mod.1138	0.050 in.
Mod.1138 (S.B.Da72-151) but pre-Mod.1523	0.090 in.
Mod.1523 (S.B.Da73-55)	0.110 in.

(b) Close the pilot's throttle lever fully, retaining the FUEL DATUM position previously set in para.B. (1)(a) and ensure that the throttle pick-up lever (6) contacts the engine control box adjustable stop (8).

(3) Re-set the throttle valve lever travel.

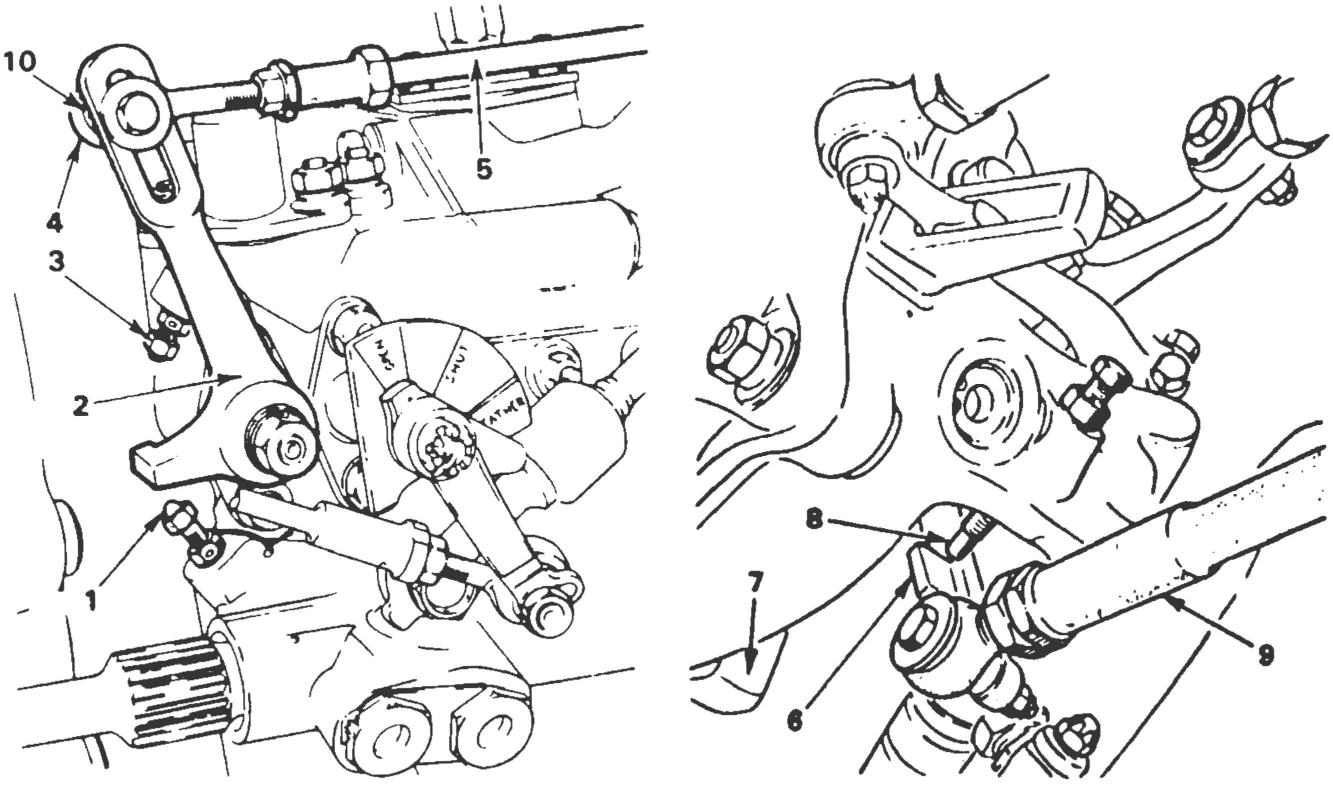
(a) Measure the clearance between the throttle valve lever (2) and the fuel control unit minimum stop (3).

(b) Re-position the throttle valve lever end-coupling (4) one serration inwards for every 0.020 in. that the clearance between the throttle valve lever (2) and the fuel control unit minimum stop (3) exceeds the following dimensions:

Pre-Mod.1138	0.100 in.
Mod.1138 (S.B.Da72-151) but pre-Mod.1523	0.120 in.
Mod.1523 (S.B.Da73-55)	0.140 in.

NOTE: An adjustment of 0.010 in. can be obtained by rotating the serrated washer (10) situated between the end-coupling (4) and the throttle valve lever (2), through 180 degrees.

Power plant - Adjustment test (cont.)



FUEL CONTROL UNIT

ENGINE CONTROL BOX

1. FUEL CONTROL UNIT MAXIMUM STOP.
2. FUEL CONTROL UNIT THROTTLE VALVE LEVER.
3. FUEL CONTROL UNIT MINIMUM STOP.
4. THROTTLE VALVE LEVER CONTROL ROD END-COUPLING.
5. THROTTLE VALVE LEVER CONTROL ROD.
6. ENGINE CONTROL BOX THROTTLE PICK-UP LEVER.
7. ENGINE CONTROL BOX MAXIMUM (FIXED) STOP.
8. ENGINE CONTROL BOX ADJUSTABLE STOP.
9. AIRCRAFT CONTROL ROD.
10. SERRATED WASHER.

G7542

Control adjustments
Fig.513

(4) Restore the throttle valve lever clearances

(a) Open the pilot's throttle lever fully, retaining the FUEL DATUM position previously set in para.B.(1)(a).

(b) Adjust the control rod (5) length between the throttle valve lever (2) and the engine control box until the throttle valve lever (2) just contacts the fuel control unit maximum stop (1).

(c) Still retaining the FUEL DATUM position previously set, close the pilot's throttle lever fully and ensure that the throttle pick-up lever (6) contacts the engine control box adjustable stop (8).

(d) Adjust the engine control box adjustable stop (8) projection, within the permissible limits, to obtain a clearance between the throttle valve lever (2) and the fuel control unit minimum stop (3) of:

Modification standard	Minimum stop (3) clearance	Adjustable stop (8) projection limits
Pre-Mod.1138	0.100 in.	0.0 in. to 0.100 in.
Mod.1138 (S.B.Da72-151) but pre-Mod.1523	0.120 in.	0.0 in. to 0.175 in.
Mod.1523 (S.B.Da73-55)	0.140 in.	0.0 in. to 0.225 in.

(e) Set the FUEL DATUM position indicator to FULL INCREASE (100 per cent) for all engine Mks.

(f) Open the pilot's throttle lever fully, then adjust the fuel control unit maximum stop (1) to obtain a minimum clearance of 0.050 in. between it and the throttle valve lever (2).

C. Adjust the turbine gas temperature (alternative method)

NOTE: The fuel trim switches are used to adjust the maximum fuel flow and so obtain the desired turbine gas temperature; this limits the use of this method, when near or below I.S.A. conditions, to adjusting for high turbine gas temperature.

(1) Adjust the control rod length (5) to obtain the required maximum turbine gas temperature.

(a) Use the fuel trim switches to reduce the turbine gas temperature below the required value (if necessary), then increase the fuel trim until the required turbine gas temperature indication has stabilized.

(b) Stop the engine without altering the FUEL DATUM setting.

(c) Open the pilot's throttle lever fully (FUEL DATUM setting still unaltered) and ensure that the throttle pick-up lever (6) contacts the engine control box maximum stop (7).

(d) Measure and note the clearance between the fuel control unit maximum stop (1) and the throttle valve lever (2).

(e) Restore the FUEL DATUM to the original setting; refer to 4. 'Ground run sequence', ACTION B.

(f) Adjust the control rod length (5) between the throttle valve lever (2) and the engine control box to give the fuel control unit maximum stop/throttle valve lever clearance obtained in para.(d) above.

(g) Set the FUEL DATUM to full INCREASE (100 per cent) and adjust the fuel control unit maximum stop (1) to obtain a minimum clearance of 0.050 in. between it and the throttle valve lever (2).

(2) Obtain the fuel control unit minimum stop (3) clearance

(a) Close the pilots' throttle lever fully and set the FUEL DATUM position indicator to:

Mk.536-7P, 536-7R and 535-7 - 85 per cent

All other Mks. - 100 per cent

(b) Adjust the engine control box adjustable stop (8), (with the throttle pick-up lever (6) contacting it) to obtain a clearance between the throttle valve lever (2) and the fuel control unit minimum stop (3) of:

Modification standard	Minimum stop (3) clearance	Adjustable stop (8) projection limits
Pre-Mod.1138	0.100 in.	0.0 in. to 0.100 in.
Mod.1138 (S.B.Da72-151) but pre-Mod.1523	0.120 in.	0.0 in. to 0.175 in.
Mod.1523 (S.B.Da73-55)	0.140 in.	0.0 in. to 0.225 in.

(c) If permissible adjustment is insufficient, re-set the throttle valve lever as instructed in para.B.

(d) Check the engine controls for full and free movement; refer to Chap.76-0, 'MAINTENANCE PRACTICES - ENGINE CONTROLS', SERVICING.

(3) Carry out the controls static checks as instructed in Chap.76-0, 'MAINTENANCE PRACTICES - ENGINE CONTROLS', STATIC CHECKS AND ADJUSTMENTS.

(4) On satisfactory completion of the controls static checks re-start the ground run at the commencement of ACTION D.

REMOVAL/RE-INSTALLATION GROUND RUNS - DRY

1. Object of ground runs

A. Removal run (RUN 1)

(1) To establish serviceability of the engine for future use.

(2) To establish a datum turbine gas temperature for the re-installation ground run.

(3) To establish the torque pressure margin above the Mintorque value.

B. Re-installation run (RUN 2)

(1) To interconnect the controls to obtain the datum turbine gas temperature recorded during the removal ground run.

(2) To check that the engine is acceptable for further service within the limits specified in Table 5.

(3) To establish a new Mintorque and torque pressure upper limit which will allow for the re-installation effect.

2. Action required before commencing removal/re-installation ground runs

A. Instrumentation and pyrometry

(1) Ensure that the r.p.m. gauge is accurately calibrated.

(2) Ensure that the T.G.T. gauge is accurately calibrated; refer to Chap. 77, 'ENGINE INDICATING'.

B. Check the engine r.p.m. and cross-check the aircraft r.p.m. gauge as follows:

(1) Fit the cannon connector on the connecting lead ERE.2382, to the r.p.m. 'IN' socket on the front of the r.p.m. digital indicator, ERE.2380, refer to Fig.513A.

(2) Remove the electrical plug from the r.p.m. gauge, fitted to the aircraft cockpit instrument panel and connect the plug to the aircraft gauge plug (female) on the connecting lead ERE.2382.

(3) Fit the aircraft gauge harness plug (male) to the r.p.m. gauge, fitted to the aircraft cockpit instrument panel.

(4) Move the digital indicator switch to 'ON'.

NOTE: The 'Normal' indicator light will illuminate if the indicator battery has an adequate charge.

(5) The indicator is ready for immediate use, but the measuring accuracy will be improved by approximately 0.1 per cent if the indicator is allowed to warm up for 30 minutes.

(6) If the 10 per cent charge indicator light illuminates the indicator can be used for a short period, but it, will require to be re-charged before further prolonged use; refer to Appendix 2.

NOTE: A full charge will allow approximately 8 hours use.

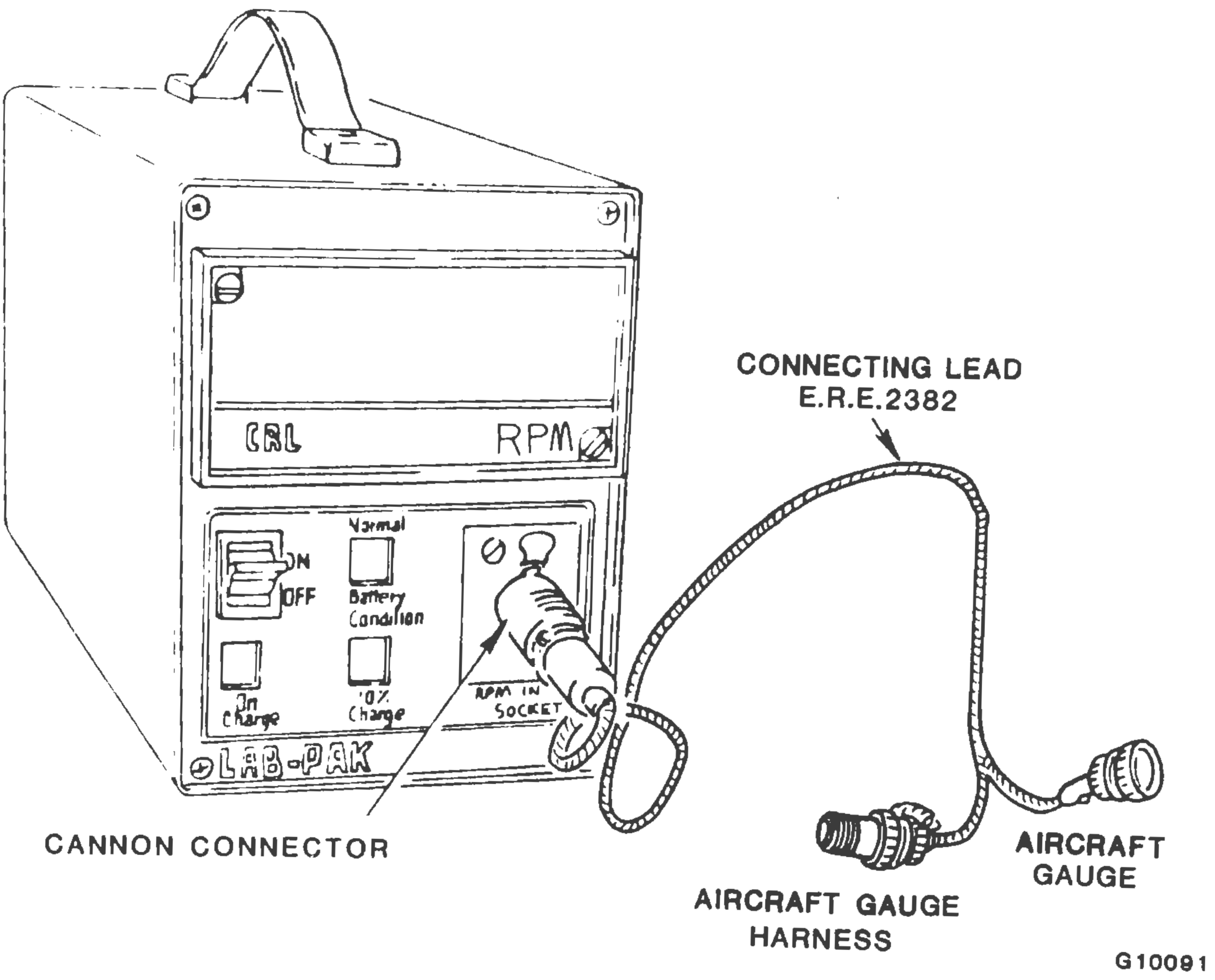
(7) On satisfactory completion of the checks effect the following:

(a) Move the digital indicator switch to 'OFF'.

(b) Disconnect the 2 plugs on the connecting lead, E.R.E.2382, from the aircraft harness lead and the r.p.m. gauge.

(c) Connect the aircraft harness electrical plug to the r.p.m. gauge.

(d) If required, remove the cannon connector from the 'IN' socket of the r.p.m. digital indicator.



R.p.m. digital indicator
Fig.513A

Power plant - Adjustment/test (cont.)

C. Check the engine T.G.T. and cross-check the aircraft T.G.T. gauge as follows:

(1) Pre-Mod.1792 engines

(a) Remove the engine thermocouples main junction box cover.

(b) Pass one end of the 2 metres (6.6 ft.) Chromel/Alumel cable, GZ.39165 or GZ.39165/2 through the aperture of the slave cover, GZ.39166 for pre-Mod.1567 engines or GZ.39167 for Mod.1567 engines.

(c) Fit the brown insulated Chromel lead of the cable under the washers on the setscrew (pre-Mod.1567) or the 4 B.A. nut on the extended setscrew (Mod.1567) which secures the red insulated harness leads to the terminal adjacent to the aircraft extension lead opening in the main junction box. Leave the harness and the aircraft extension leads connected.

(d) Fit the blue insulated Alumel lead of the cable under the washers on the setscrew (pre-Mod.1567) or the 4 B.A. nut on the extended setscrew (Mod.1567) which secures the blue insulated harness leads to the other terminal in the main junction box. Leave the harness and the aircraft extension leads connected.

(e) Fit the slave cover to the main junction box.

(2) Mod.1792 engines

(a) Remove the dust cap from the socket on the aluminium body, mounted on the engine thermocouples main junction box, then connect the 2 metres (6.6 ft.) Chromel/Alumel cable and plug, GZ.39164 or GZ.39614/2, to the socket.

JT
Alr
MDa
D

(3) Using the terminal block, connect the 27 metres (88.6 ft.) Copper/Constantan cable, ERE.2347, to the 2 metres (6.6 ft.) Chromel/Alumel cable, GZ.39165 (pre-Mod.1792) or cable and plug, GZ.39164, (Mod.1792); refer to Fig.513B.

(a) Using the socket supplied with GZ.39164/2 and GZ.39165/2 connect the 27 metres (88.6 ft.) Copper/ Constantan cable ERE.2347, to the 2 metres (6.6 ft.) Chromel/Alumel cable GZ.39165/2 (pre-Mod. 1792) or cable and plug, GZ.39164/2 (Mod.1792), refer to Fig.513C.

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(4) Connect the other end of the Copper/Constantan cable, ERE.2347, to the terminal posts of potentiometer R.R. type GZ.38989 or Foster type 3154/1883, 3155/DP2163, 3156/DP2163 as follows:-

(a) Connect the white insulated copper lead of the cable to the red terminal post of the potentiometer.

(b) Connect the blue insulated constantan lead of the cable to the black terminal post of the potentiometer.

NOTES: (1) The length of the Copper/Constantan cable can be reduced to suit operators requirements.

(2) When using R.R. potentiometer type GZ.38989, the leads can be connected to either set 1 or set 2 terminal posts.

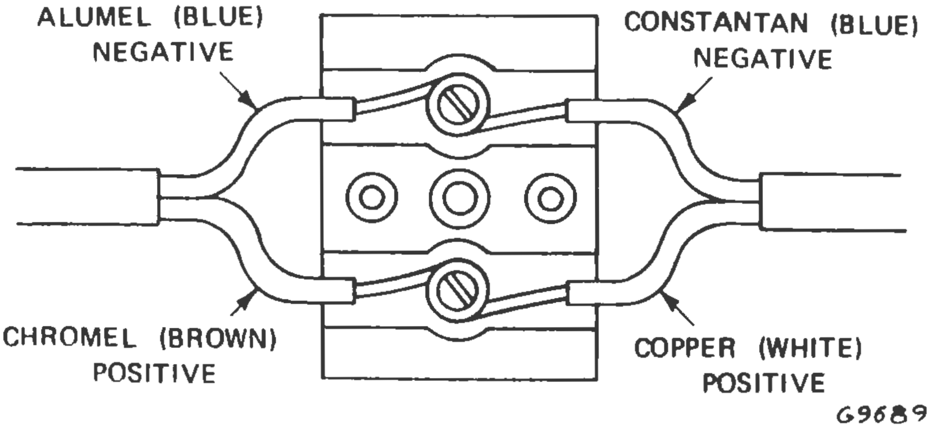
(3) Potentiometers other than those detailed in para.(4) can be used provided they comply with the following:-

(a) Scale range 0-1000 deg.C. Nickel Chromium/Nickel Aluminium BS.4937, Type K.

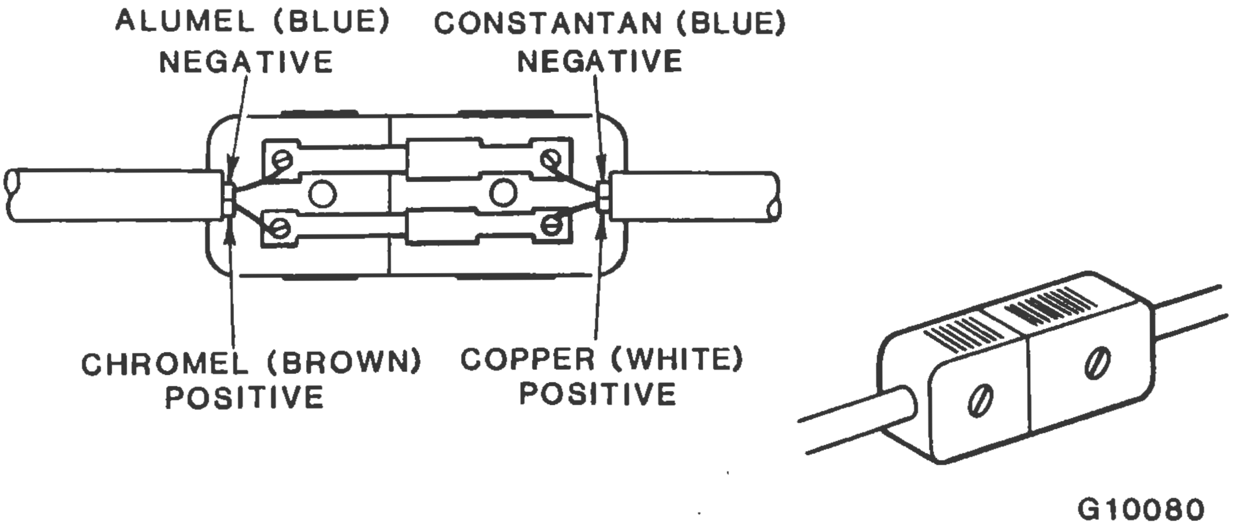
(b) Available millivolt source (60 mV) for calibration of 8 or 25 ohms T.G.T. indicators.

(c) Automatic or manual cold junction temperature compensation.

(d) Instrument accuracy of ± 0.2 per cent of span maximum.



(GZ.39164 and GZ.39165)
Cable leads connected to terminal block
Fig.513B



(GZ.39164/2 and GZ.39165/2)
Cable leads connected to plug assembly
Fig.513C

(c) Position the potentiometer in the place where it will be operated and allow approximately 15 minutes for the carcase temperature to stabilize before taking any readings.

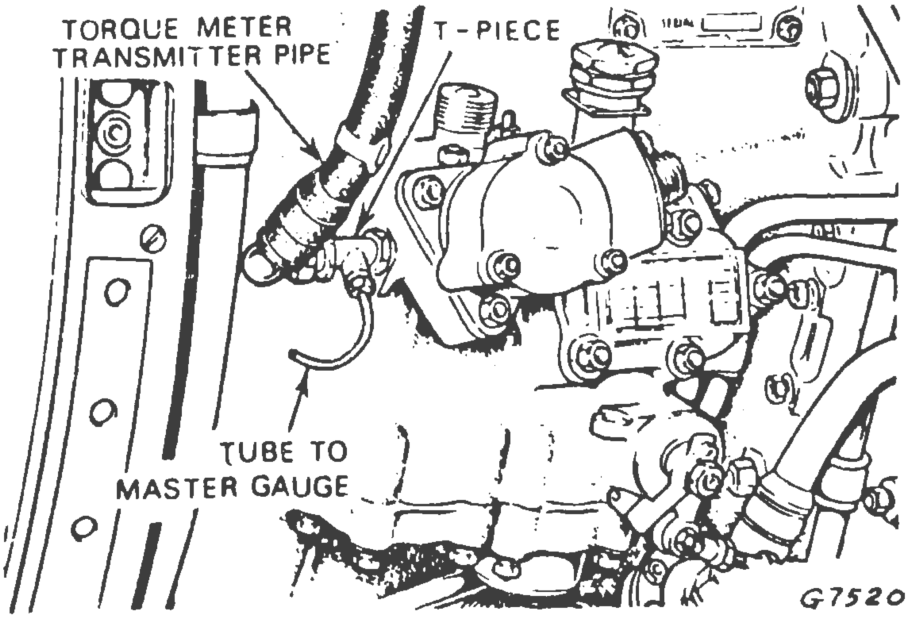
(d) Ensure that the range cap is securely connected on the 60 M.V. socket, and that the potential divider switch is OFF. When using R.R. type GZ.38989, select 60 M.V. on the M.V. switch (situated on the bottom right side of the instrument panel) by moving the switch to the right.

(e) Zero the galvanometer, with button K1 pressed, by rotating the standardising rheostat knob (clockwise moves the needle to the right). On R.R. type GZ.38989 ensure that the galvanometer switch is not in the off position, then push the lever of the MEASURE/STANDARDISE switch to STANDARDISE and zero the galvanometer using the standardising rheostat knob (clockwise moves the needle to the right). If any difficulty is experienced in stabilizing or adjusting the needle, renew the batteries.

(f) Obtain the potentiometer terminal temperature from the mercury thermometer attached to the carcase of the potentiometer, then set this temperature on the cold junction scale (C.J. scale, black numerals).

(g) Set the main temperature scale (0 - 1400 degrees C., black numerals) to approximately the required T.G.T. (this will avoid damage to the galvanometer by excessive deflections when the T.G.T. readings are taken during the ground run).

NOTE: Refer to ACTION 4.D. for the method of operation of the Foster Potentiometer when checking the T.G.T. at maximum take-off conditions.



T-piece adapter - water/methanol control unit
Fig.514

(5) Connect a Bourdon tube type master pressure gauge (GZ.36755/1) between the torquemeter pressure transmitter oil pipe and the connection on the water/methanol control unit, using a T-piece adapter and a suitable length of tubing; refer to Fig.514.

(6) Alternatively, when using torquemeter pressure digital indicator, ERE.2317, connect T-piece adapter, GZ.39107, between the torquemeter transmitter oil pipe and the connection on the water/methanol control unit, then connect transducer, ERE.2320, to the T-piece adapter ensuring that the sealing washer is fitted between the adapter and transducer; refer to Fig.A and Fig.B.

NOTE: The Dowty sealing washer is supplied with the transducer.

(a) Connect the 6 pin Bendix connector on the coupling cable, ERE.2348 to the transducer, then route the cable carefully to the aircraft cockpit and connect the 5 pin Cannon connector on the cable to the socket on the front panel of the digital indicator.

(b) Move the digital indicator switch to 'ON'.

NOTE: The 'Normal' indicator light will illuminate if the indicator battery has adequate charge.

(c) The indicator is ready for immediate use, but measuring accuracy will be improved by approximately 0.1 per cent if the indicator is allowed to warm up for 30 minutes.

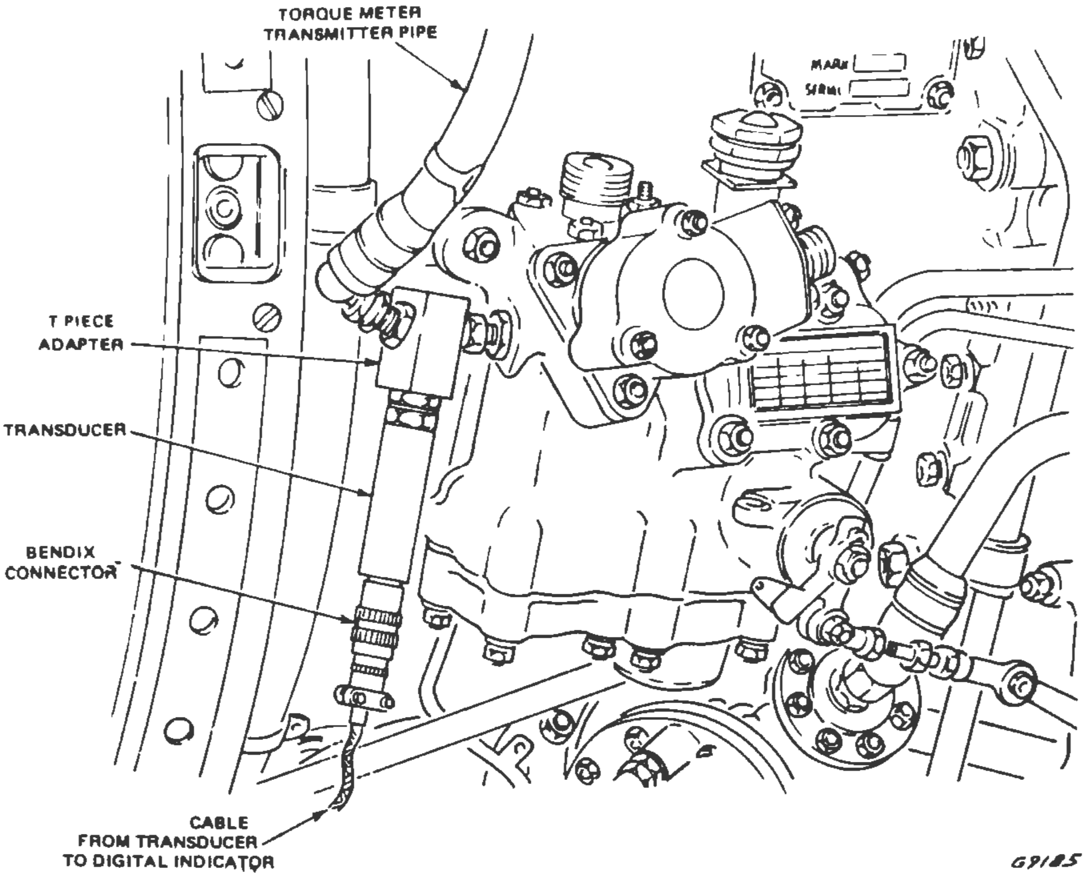
(d) If the '10% Charge' indicator light illuminates the indicator can be used for a short period, but it will require to be re-charged before further prolonged use; refer to Appendix 1, para.3.

NOTE: A full charge will allow approximately 8 hours use.

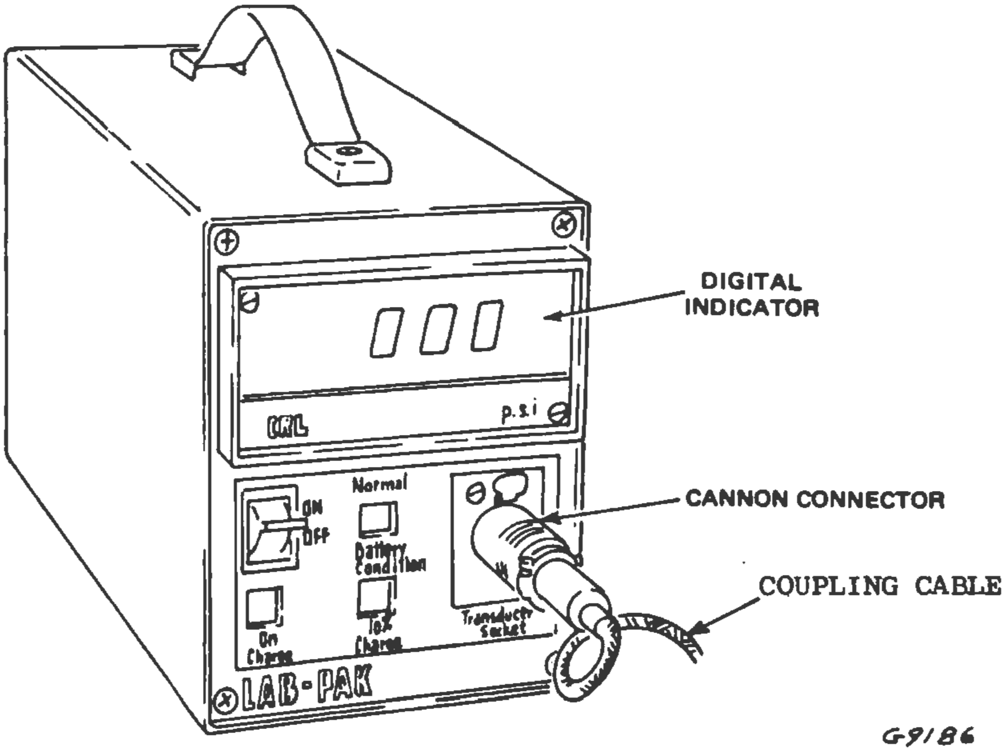
(e) The transducer and digital indicator should be used together as a matched set. If either the transducer or digital indicator have to be replaced (because of a fault) the instrument set should be re-calibrated before further use; refer to Appendix 1, para.2.

(7) On satisfactory completion of the checks, remove the equipment fitted at paragraphs (5) or (6).

Power plant - Adjustment/test (cont.)


TORQUE METER TRANSMITTER PIPE
T PIECE ADAPTER
TRANSDUCER
BENDIX CONNECTOR
CABLE FROM TRANSDUCER TO DIGITAL INDICATOR
G9185

T-piece adapter and transducer - water/methanol control unit
Fig.A



Torquemeter pressure digital indicator
Fig.B

D. Record the following ambient conditions (refer to para.F.)

(1) Outside air temperature in degrees C. or F.

(a) Suspend a mercury thermometer from a safe position, adjacent to and in the shade of the aircraft, and record the ambient air temperature.

(2) Pressure altitude in feet

(a) Obtain the prevailing pressure altitude from the aircraft altimeter by setting it to 1013 millibars and reading off the pressure altitude in feet, above or below sea level.

(3) Dew point in degrees C. or F. If the dew point information is not obtainable record the humidity, using a wet and dry bulb thermometer, and convert to the dew point; refer to Sub-section 4E, "CHARTS'.

NOTE: If the outside air temperature is below 10 degrees C. (50 degrees F.), humidity corrections are not required.

E. Record the following data (refer to para. F.)

(1) Fuel datum trim position for starting; refer to Section 3, 'ENGINE STARTING, MOTORING AND STOPPING DRILLS'.

(2) Fuel datum trim position for the ambient conditions, corrected for humidity only if the outside air temperature is above 10 degrees C.; refer to Sub-section 4E, 'CHARTS'.

(3) Maximum Data-plate Take-off turbine gas temperature corrected for ambient conditions; refer to Sub-section 4E, 'CHARTS'.

(4) 'OPERATING LIMITATION' Take-off turbine gas temperature corrected for ambient conditions; refer to Section 1, 'ENGINE HANDLING' and Sub-section 4E, 'CHARTS'.

(5) Engine power check pressure at 70 and 100 degrees C. oil inlet temperature.

NOTE: The information required for para.(5) can be obtained from the engine 'Inspection and Test Certificate' which can be found in the engine log-book.

(6) Mintorque values at 70 and 100 degrees C. oil inlet temperature, and oil inlet temperature at which mintorque was declared (from the engine log-book or aircraft documents).

(7) Torque pressure upper limit values at 70 and 100 degrees C. oil inlet temperature (from the engine log-book or aircraft documents).

(8) Data-plate water/methanol check pressure.

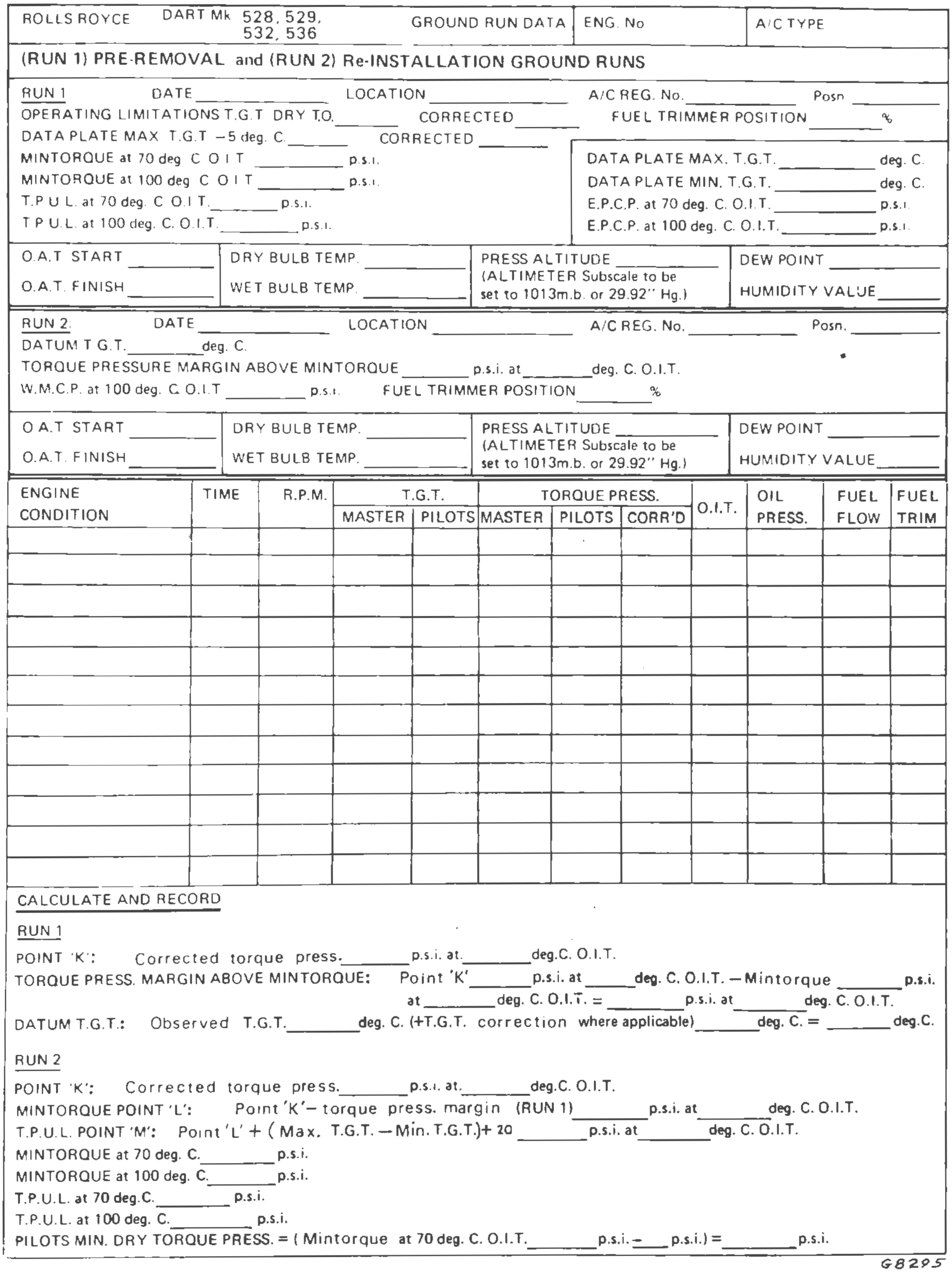
(9) Water/methanol Take-off maximum turbine gas temperature limit; refer to Section 1, 'ENGINE HANDLING', para.5.

NOTE: The actions given in Table 5 are applicable to both RUN 1 and RUN 2 with the exception of the turbine gas temperature and torque pressure limits which are dealt with separately.

Power plant - Adjustment/test (cont.)

F. Engine ground run pro forma

(1) Fig.514A shows a specimen engine ground run pro forma which may be completed for each ground run, as instructed in para.4., 5., 6. and 7., and retained for record and/or reference purposes.



ROLLS ROYCE	DART Mk 528, 529, 532, 536	GROUND RUN DATA	ENG. No	A/C TYPE

(RUN 1) PRE-REMOVAL and (RUN 2) Re-INSTALLATION GROUND RUNS

RUN 1 DATE ________ LOCATION ________ A/C REG. No. ________ Posn ________
OPERATING LIMITATIONS T.G.T DRY T.O. ________ CORRECTED ________ FUEL TRIMMER POSITION ________ %
DATA PLATE MAX T.G.T −5 deg. C. ________ CORRECTED ________
MINTORQUE at 70 deg C O I T ________ p.s.i.
MINTORQUE at 100 deg C O I T ________ p.s.i.
T.P U L. at 70 deg. C O.I T. ________ p.s.i.
T P U.L. at 100 deg. C. O.I.T. ________ p.s.i.

DATA PLATE MAX. T.G.T. ________ deg. C.
DATA PLATE MIN. T.G.T. ________ deg. C.
E.P.C.P. at 70 deg. C. O.I.T. ________ p.s.i.
E.P.C.P. at 100 deg. C. O.I.T. ________ p.s.i.

O.A.T START ________	DRY BULB TEMP. ________	PRESS ALTITUDE ________	DEW POINT ________
O.A.T. FINISH ________	WET BULB TEMP. ________	(ALTIMETER Subscale to be set to 1013m.b. or 29.92" Hg.)	HUMIDITY VALUE ________

RUN 2 DATE ________ LOCATION ________ A/C REG. No. ________ Posn. ________
DATUM T G.T. ________ deg. C.
TORQUE PRESSURE MARGIN ABOVE MINTORQUE ________ p.s.i. at ________ deg. C. O.I.T.
W.M.C.P. at 100 deg. C. O.I.T ________ p.s.i. FUEL TRIMMER POSITION ________ %

O A.T START ________	DRY BULB TEMP. ________	PRESS ALTITUDE ________	DEW POINT ________
O.A.T. FINISH ________	WET BULB TEMP. ________	(ALTIMETER Subscale to be set to 1013m.b. or 29.92" Hg.)	HUMIDITY VALUE ________

ENGINE CONDITION	TIME	R.P.M.	T.G.T.		TORQUE PRESS.			O.I.T.	OIL PRESS.	FUEL FLOW	FUEL TRIM
			MASTER	PILOTS	MASTER	PILOTS	CORR'D				

CALCULATE AND RECORD

RUN 1
POINT 'K': Corrected torque press. ________ p.s.i. at ________ deg.C. O.I.T.
TORQUE PRESS. MARGIN ABOVE MINTORQUE: Point 'K' ________ p.s.i. at ________ deg. C. O.I.T. − Mintorque ________ p.s.i. at ________ deg. C. O.I.T. = ________ p.s.i. at ________ deg. C. O.I.T.
DATUM T.G.T.: Observed T.G.T. ________ deg. C. (+T.G.T. correction where applicable) ________ deg. C. = ________ deg.C.

RUN 2
POINT 'K': Corrected torque press. ________ p.s.i. at ________ deg.C. O.I.T.
MINTORQUE POINT 'L': Point 'K' − torque press. margin (RUN 1) ________ p.s.i. at ________ deg. C. O.I.T.
T.P.U.L. POINT 'M': Point 'L' + (Max. T.G.T. − Min. T.G.T.) + 20 ________ p.s.i. at ________ deg. C. O.I.T.
MINTORQUE at 70 deg. C. ________ p.s.i.
MINTORQUE at 100 deg. C. ________ p.s.i.
T.P.U.L. at 70 deg.C. ________ p.s.i.
T.P.U.L. at 100 deg. C. ________ p.s.i.
PILOTS MIN. DRY TORQUE PRESS. = (Mintorque at 70 deg. C. O.I.T. ________ p.s.i. − ____ p.s.i.) = ________ p.s.i.

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Specimen engine ground run pro forma
Fig.514A

3. Abbreviations

Wherever possible, abbreviations have been avoided, however, because of space restrictions some abbreviations have been used in the tables and illustrations. Listed below are the abbreviations and their definitions.

C.	Centigrade
E.P.C.P.	engine power check pressure
F.	Fahrenheit
F.C.U.	fuel control unit
F.F.P.S.	flight fine pitch stop
ft.	feet
G.P.C.P.	ground power check pressure
I.S.A.	International standard atmosphere
Max.	maximum
Mk.	Mark
Min.	minimum
Mod.	modification
O.A.T.	outside air temperature
O.I.T.	oil inlet temperature
P.A.	pressure altitude
P.C.U.	propeller controller unit
p.s.i.	pounds per square inch
r.p.m.	revolutions per minute
S.B.	Service Bulletin
S.H.P.	shaft horse-power
S.L.s	sea level
T.O.	Take-off
T.P.U.L.	Torque pressure upper limit
T.V.	throttle valve
T.G.T.	turbine gas temperature
w/m	water/methanol
W.M.C.P.	water/methanol check pressure
W.M.C.U.	water/methanol control unit

REMOVAL/RE-INSTALLATION GROUND RUNS - DRY

1. Object of ground runs

A. Removal run (RUN 1)

(1) To establish serviceability of the engine for future use.

(2) To establish a datum turbine gas temperature for the re-installation ground run.

(3) To establish the torque pressure margin above the Mintorque value.

B. Re-installation run (RUN 2)

(1) To interconnect the controls to obtain the datum turbine gas temperature recorded during the removal ground run.

(2) To check that the engine is acceptable for further service within the limits specified in Table 5.

(3) To establish a new Mintorque and torque pressure upper limit which will allow for the re-installation effect.

2. Action required before commencing removal/re-installation ground runs

A. Instrumentation and pyrometry

(1) Ensure that the r.p.m. gauge is accurately calibrated.

(2) Ensure that the engine and the associated aircraft pyrometry systems are fully serviceable and that the T.G.T. gauge is accurately calibrated; refer to Chap.77, 'ENGINE INDICATING'.

(3) To check the T.G.T. and cross-check the aircraft T.G.T. gauge connect a Foster Potentiometer, type 3154/1833, 3155/DP, 3156/DP or Potentiometer R.R. type GZ.38989 to the aircraft T.G.T. cable terminals in the engine thermocouples main junction box (leave the aircraft T.G.T. cable terminals connected) using a suitable length of Chromel/Alumel or Copper/Constantan cable; on R.R. type GZ.38989 either No.1 or No.2 input terminals may be used. Ensure that correct polarity is maintained; the Alumel cable and the Constantan cable are magnetic (NEGATIVE).

NOTE: Sixty feet of cable (ERE.2255) will allow the potentiometer to be operated in the crew compartment. The cable length can be adjusted to suit the particular installation.

(a) Position the potentiometer in the place where it will be operated, for approximately 15 minutes, before any readings are taken; this will allow the carcase temperature of the potentiometer to stabilise.

Power plant - Adjustment/test (cont.)

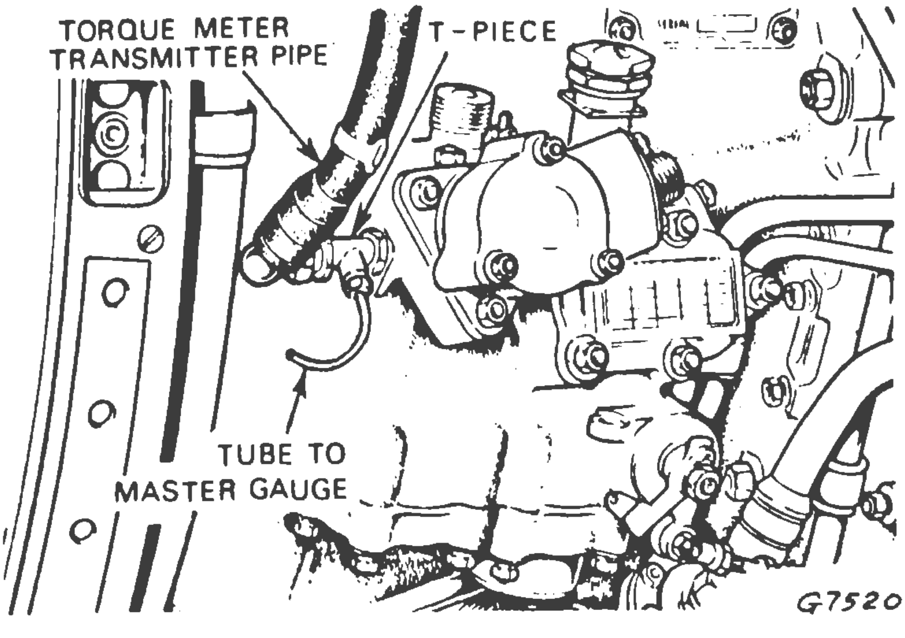
(b) Ensure that the range cap is securely connected on the 60 M.V. socket, and that the potential divider switch is OFF. When using R.R. type GZ.38989, select 60 M.V. on the M.V. switch (situated on the bottom right side of the instrument panel) by moving the switch to the right.

(c) Zero the galvanometer, with button K1 pressed, by rotating the standardising rheostat knob (clockwise moves the needle to the right). On R.R. type GZ.38989 ensure that the galvanometer switch is not in the off position, then push the lever of the MEASURE/STANDARDISE switch to STANDARDISE and zero the galvanometer using the standardising rheostat knob (clockwise moves the needle to the right). If any difficulty is experienced in stabilising or adjusting the needle, renew the batteries.

(d) Obtain the potentiometer terminal temperature from the mercury thermometer attached to the carcase of the potentiometer, then set this temperature on the cold junction scale (C.J. scale, black numerals).

(e) Set the main temperature scale (0 - 1400 degrees C., black numerals) to approximately the required T.G.T. (this will avoid damage to the galvanometer by excessive deflections when the T.G.T. readings are taken during the ground run).

NOTE: Refer to ACTION 4.D. for the method of operation of the Foster Potentiometer when checking the T.G.T. at maximum Take-off conditions.



T-piece adapter - water/methanol control unit
Fig.514

(4) Connect a Bourdon tube type master pressure gauge (GZ.36755) between the torque pressure transmitter oil pipe and the connection on the water/methanol control unit, using a T-piece adapter and a suitable length of tubing (Fig.514).

B. Record the following ambient conditions (refer to para.D.)

(1) Outside air temperature in degrees C. or F.

(a) Suspend a mercury thermometer from a safe position, adjacent to and in the shade of the aircraft, and record the ambient air temperature.

(2) Pressure altitude in feet

(a) Obtain the prevailing pressure altitude from the aircraft altimeter by setting it to 1013 millibars and reading off the pressure altitude in feet, above or below sea level.

(3) Dew point in degrees C. or F. If the dew point information is not obtainable record the humidity, using a wet and dry bulb thermometer, and convert to the dew point; refer to Sub-section 4E, "CHARTS'.

NOTE: If the outside air temperature is below 10 degrees C. (50 degrees F.), humidity corrections are not required.

C. Record the following data (refer to para.D.)

(1) Fuel datum trim position for starting; refer to Section 3, 'ENGINE STARTING, MOTORING AND STOPPING DRILLS'.

(2) Fuel datum trim position for the ambient conditions, corrected for humidity only if the outside air temperature is above 10 degrees C.; refer to Sub-section 4E, 'CHARTS'.

(3) Maximum Data-plate Take-off turbine gas temperature corrected for ambient conditions; refer to Sub-section 4E, 'CHARTS'.

(4) 'OPERATING LIMITATION' Take-off turbine gas temperature corrected for ambient conditions; refer to Section 1, 'ENGINE HANDLING' and Sub-section 4E, 'CHARTS'.

(5) Engine power check pressure at 70 and 100 degrees C. oil inlet temperature.

NOTE: The information required for para.(5) can be obtained from the engine 'Inspection and Test Certificate' which can be found in the engine log-book.

(6) Mintorque values at 70 and 100 degrees C. oil inlet temperature, and oil inlet temperature at which mintorque was declared (from the engine log-book or aircraft documents).

(7) Torque pressure upper limit values at 70 and 100 degrees C. oil inlet temperature (from the engine log-book or aircraft documents).

(8) Data-plate water/methanol check pressure.

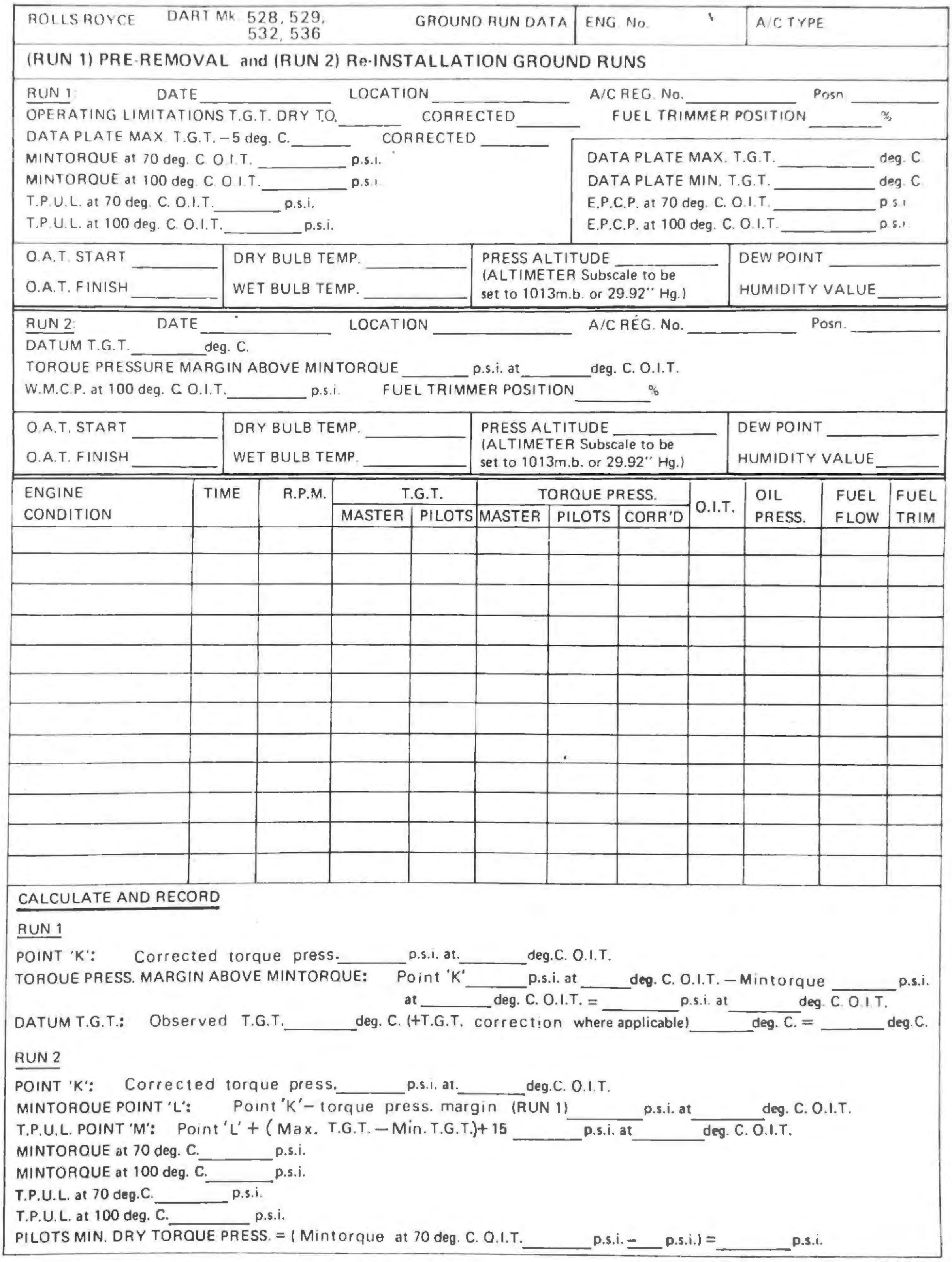
(9) Water/methanol Take-off maximum turbine gas temperature limit; refer to Section 1, 'ENGINE HANDLING', para.5.

NOTE: The actions given in Table 5 are applicable to both RUN 1 and RUN 2 with the exception of the turbine gas temperature and torque pressure limits which are dealt with separately.

Power plant - Adjustment/test (cont.)

D. Engine ground run pro forma

(1) Fig.514A shows a specimen engine ground run pro forma which may be completed for each ground run, as instructed in para.4., 5., 6. and 7., and retained for record and/or reference purposes.



ROLLS ROYCE DART Mk. 528, 529, 532, 536 GROUND RUN DATA | ENG. No. | A/C TYPE

(RUN 1) PRE-REMOVAL and (RUN 2) Re-INSTALLATION GROUND RUNS

RUN 1: DATE ________ LOCATION ________ A/C REG. No. ________ Posn. ________
OPERATING LIMITATIONS T.G.T. DRY T.O. ________ CORRECTED ________ FUEL TRIMMER POSITION ________ %
DATA PLATE MAX. T.G.T. – 5 deg. C. ________ CORRECTED ________
MINTORQUE at 70 deg. C. O.I.T. ________ p.s.i.
MINTORQUE at 100 deg. C. O.I.T. ________ p.s.i.
T.P.U.L. at 70 deg. C. O.I.T. ________ p.s.i.
T.P.U.L. at 100 deg. C. O.I.T. ________ p.s.i.

DATA PLATE MAX. T.G.T. ________ deg. C.
DATA PLATE MIN. T.G.T. ________ deg. C.
E.P.C.P. at 70 deg. C. O.I.T. ________ p.s.i.
E.P.C.P. at 100 deg. C. O.I.T. ________ p.s.i.

O.A.T. START ________	DRY BULB TEMP. ________	PRESS ALTITUDE ________	DEW POINT ________
O.A.T. FINISH ________	WET BULB TEMP. ________	(ALTIMETER Subscale to be set to 1013m.b. or 29.92" Hg.)	HUMIDITY VALUE ________

RUN 2: DATE ________ LOCATION ________ A/C REG. No. ________ Posn. ________
DATUM T.G.T. ________ deg. C.
TORQUE PRESSURE MARGIN ABOVE MINTORQUE ________ p.s.i. at ________ deg. C. O.I.T.
W.M.C.P. at 100 deg. C. O.I.T. ________ p.s.i. FUEL TRIMMER POSITION ________ %

O.A.T. START ________	DRY BULB TEMP. ________	PRESS ALTITUDE ________	DEW POINT ________
O.A.T. FINISH ________	WET BULB TEMP. ________	(ALTIMETER Subscale to be set to 1013m.b. or 29.92" Hg.)	HUMIDITY VALUE ________

ENGINE CONDITION	TIME	R.P.M.	T.G.T.		TORQUE PRESS.			O.I.T.	OIL PRESS.	FUEL FLOW	FUEL TRIM
			MASTER	PILOTS	MASTER	PILOTS	CORR'D				

CALCULATE AND RECORD

RUN 1

POINT 'K': Corrected torque press. ________ p.s.i. at ________ deg.C. O.I.T.
TORQUE PRESS. MARGIN ABOVE MINTORQUE: Point 'K' ________ p.s.i. at ________ deg. C. O.I.T. – Mintorque ________ p.s.i. at ________ deg. C. O.I.T. = ________ p.s.i. at ________ deg. C. O.I.T.
DATUM T.G.T.: Observed T.G.T. ________ deg. C. (+T.G.T. correction where applicable) ________ deg. C. = ________ deg.C.

RUN 2

POINT 'K': Corrected torque press. ________ p.s.i. at ________ deg.C. O.I.T.
MINTORQUE POINT 'L': Point 'K' – torque press. margin (RUN 1) ________ p.s.i. at ________ deg. C. O.I.T.
T.P.U.L. POINT 'M': Point 'L' + (Max. T.G.T. – Min. T.G.T.) + 15 ________ p.s.i. at ________ deg. C. O.I.T.
MINTORQUE at 70 deg. C. ________ p.s.i.
MINTORQUE at 100 deg. C. ________ p.s.i.
T.P.U.L. at 70 deg.C. ________ p.s.i.
T.P.U.L. at 100 deg. C. ________ p.s.i.
PILOTS MIN. DRY TORQUE PRESS. = (Mintorque at 70 deg. C. O.I.T. ________ p.s.i. – ________ p.s.i.) = ________ p.s.i.

G8295

Specimen engine ground run pro forma
Fig.514A

3. Abbreviations

Wherever possible, abbreviations have been avoided, however, because of space restrictions some abbreviations have been used in the tables and illustrations. Listed below are the abbreviations and their definitions.

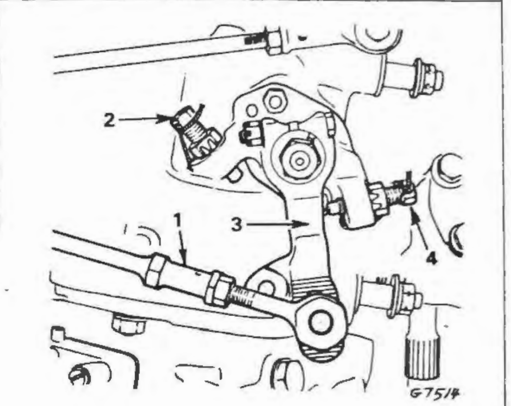
C.	Centigrade
E.P.C.P.	engine power check pressure
F.	Fahrenheit
F.C.U.	fuel control unit
F.F.P.S.	flight fine pitch stop
ft.	feet
G.P.C.P.	ground power check pressure
I.S.A.	International standard atmosphere
Max.	maximum
Mk.	Mark
Min.	minimum
Mod.	modification
O.A.T.	outside air temperature
O.I.T.	oil inlet temperature
P.A.	pressure altitude
P.C.U.	propeller controller unit
p.s.i.	pounds per square inch
r.p.m.	revolutions per minute
S.B.	Service Bulletin
S.H.P.	shaft horse-power
S.L.	sea level
T.O.	Take-off
T.P.U.L.	Torque pressure upper limit
T.V.	throttle valve
T.G.T.	turbine gas temperature
w/m	water/methanol
W.M.C.P.	water/methanol check pressure
W.M.C.U.	water/methanol control unit

TABLE 5

4. Ground run sequence

ACTION	CHECK	ACCEPTANCE LIMITS	ACTION IF INCORRECT	RECTIFICATION, CALCULATION AND ILLUSTRATIONS
NOTE: Actions A. B. and D. are for checking the engine interconnection; action C. is for function checking the hot-air valve.				
A. Set the FUEL DATUM; start the engine as instructed in Section 3, 'ENGINE STARTING, MOTORING AND STOPPING DRILLS'	Oil pressure	Needle off the stop	Stop the engine	Refer to 'POWER PLANT - TROUBLE SHOOTING', Oil system defects (page block 101).
	T.G.T. during start	Maximum: 930 degrees C.	Stop the engine	Refer to 'POWER PLANT - TROUBLE SHOOTING', Engine starting faults (page block 101).
	T.G.T. when stabilized	Maximum: 550 degrees C.	Stop the engine	Refer to 'POWER PLANT - TROUBLE SHOOTING', Engine starting faults (page block 101).
	Oil inlet temperature	Minimum: minus 15 degrees C.	Run engine at up to 11,000 r.p.m. to achieve the required minimum temperature	
B. Set the FUEL DATUM for ambient conditions; refer to Sub-section 4E 'CHARTS'. Correct this setting for humidity if the outside air temperature is plus 10 degrees C. and above; refer to Sub-section 4E 'CHARTS'.				
C. Set the throttle to obtain 10,000 r.p.m. approximately	Immediately the throttle is moved check the low oil pressure warning light	Light is extinguished when the oil pressure reaches 5 to 6 p.s.i.	Stop the engine	Refer to 'POWER PLANT - TROUBLE SHOOTING' Oil system defects (page block 101).
	Oil pressure	Steady increase	Stop the engine	Refer to 'POWER PLANT - TROUBLE SHOOTING', Oil system defects, (page block 101).
(1) 2-position valve or 3-position valve (Mod. 1397) with half-heat unused (Mod.1434):	Hot air valve (fuel heater)			
Switch fuel heater ON		Small reduction in r.p.m. (approximately 50 r.p.m.)	Feel for hot air discharge from heater	Refer to Chapter 75-1-1, 'MAINTENANCE PRACTICES - HOT AIR VALVE'
Switch fuel heater OFF		R.p.m. restored to original value	Feel that discharge has ceased entirely	

TABLE 5 (cont.)

ACTION	CHECK	ACCEPTANCE LIMITS	ACTION IF INCORRECT	RECTIFICATION, CALCULATIONS AND ILLUSTRATIONS
C. (cont.)				
(2) 3-position valve (Mod.1397):				
Switch fuel heater ON.				
Select HALF heat		Small reduction in r.p.m. (approximately 50 r.p.m.)	Feel for warm air discharge from heater	Refer to Chapter 75-1-1, 'MAINTENANCE PRACTICES - HOT AIR VALVE'
Select FULL heat		Further small reduction in r.p.m. (approximately 50 r.p.m.)	Feel for hot air discharge from heater	
Switch fuel heater OFF		R.p.m. restored to original value	Feel that discharge has ceased entirely	
NOTES: (1) Since oil inlet temperature increases with time at full throttle, the checks in ACTION D are listed in sequence of increasing oil inlet temperature. (2) Ensure that unnecessary electrical load is switched off and that cabin compressors are unloaded.				 R.p.m. control lever and stops Fig.515
D. Open the throttle fully	R.p.m.	Minimum: 15,000 r.p.m. Maximum: 15,050 r.p.m.	Stop the engine	(1) Refer to 'POWER PLANT - TROUBLE SHOOTING', R.p.m. faults (page block 101). (2) If the error exceeds 400 r.p.m. do not attempt to reset the engine r.p.m. before checking instrumentation and propeller equipment.
	Oil inlet temperature	Minimum: 65 degrees C. Maximum: 75 degrees C.	If below 65 degrees C continue run until this temperature is achieved; if above 75 degrees C. run at idle until below this temperature	(3) Adjust the rod length (1) between the propeller control unit r.p.m. control lever (3) and the cross shaft lever (Fig.515). NOTE: One turn of the rod (1) clockwise (viewed from the rear of the engine) should increase the maximum engine r.p.m. by 200 approximately. (4) Open and shut the pilot's throttle lever fully and check that the propeller control unit r.p.m. control lever (3) is at least 0.050 in. clear of the maximum and minimum stops (4) and (2); adjust the stops as necessary.
	Oil pressure; record observed pressure	Normal: 12 to 35 p.s.i.	Stop the engine	Refer to 'POWER PLANT - TROUBLE SHOOTING', Oil system defects' (page block 101).

D. Turbine gas temperature (cont.) ***

(1) Use Foster Potentiometer, types 3154/1883, 3155/DP or 3156/DP; refer to para.2.A.(3)(a) to (e).

(a) Press button K2 and zero the galvanometer by rotating the main scale knob (clockwise moves the needle to the right).

(b) When the galvanometer has no deflections, with button K2 pressed, the T.G.T. reading is stabilised and can be read from the potentiometer main scale and the aircraft T.G.T. gauge.

(c) It is essential to repeat the instructions in para.2.A.(3)(c) and (d) at regular intervals to ensure that the galvanometer remains zeroed.

(2) Use Potentiometer R.R. type GZ.38989; refer to para.2.A.(3)(a) to (e).

(a) Select 1 or 2 on the left-hand rotary switch, depending on the input terminals being used.

(b) Select the OFF position on the right-hand rotary switch.

(c) Push the lever of the MEASURE/STANDARDISE switch to MEASURE and zero the galvanometer, using the main scale adjustment knob (clockwise moves the needle to the right).

(d) When the galvanometer has no deflections, with MEASURE selected, the T.G.T. reading is stabilised and can be read from the potentiometer main scale and the aircraft T.G.T. gauge.

(e) It is essential to repeat the instructions in para.2.A.(3)(c) and (d) at regular intervals to ensure that the galvanometer remains zeroed.

ACTION	CHECK	ACCEPTANCE LIMITS	ACTION IF INCORRECT	RECTIFICATION, CALCULATIONS AND ILLUSTRATIONS
D. (cont.) RUN 1 (Pre-removal run)	NOTE: When checking the torque pressure the O.I.T. should be as near as possible to the O.I.T. at which the mintorque was obtained during the installation ground run.			
Continue running engine at full throttle for a minimum of 4 minutes	Torque pressure; record observed pressure shown on aircraft and master torque pressure gauge; refer to para.2.A.(4). Record T.G.T.	Refer to 5. 'Establish the torque pressure margin above the min-torque value'. NOTE: This instruction is located immediately following TABLE 5.		
	Oil inlet temperature and record same	Min. 85 degrees C. Max. 100 degrees C.	Refer to Section 4, 'ENGINE GROUND RUNNING PROCEDURES', para.8.C.	
If necessary, continue running engine at full throttle until T.G.T. has stabilized Min. 4 minutes Max. 5 minutes	Turbine gas temperature * * *	Between the corrected OPERATING LIMITATIONS for TAKE-OFF T.G.T. without water/methanol (refer to Section 1, 'ENGINE HANDLING') and corrected DATA-PLATE TAKE-OFF MAX. T.G.T. minus 5 degrees C. Refer to Sub-section 4E, 'CHARTS' for T.G.T. corrections.	Stop the engine. Re-set the controls to obtain the correct T.G.T. then re-start the ground run at the commencement of Action D. NOTE: Ensure that oil inlet temperature is below 70 degrees C. before re-commencing ground run.	Refer to 'POWER PLANT - TROUBLE SHOOTING', T.G.T. faults (page block 101). Refer to para.8., Re-set the engine controls.
NOTE: On satisfactory completion of RUN 1 (Pre-removal run) calculate the datum T.G.T. required when carrying out RUN 2 (Re-installation run) by ADDING the T.G.T. correction used during RUN 1 to the observed T.G.T.; record the result.				
	Oil inlet temperature	120 degrees MAXIMUM		

D. Turbine gas temperature (cont.) * * *

(1) Use Foster Potentiometer, types 3154/1883, 3155/DP or 3156/DP; refer to para.2.A.(3)(a) to (e).

(a) Press button K2 and zero the galvanometer by rotating the main scale knob (clockwise moves the needle to the right).

(b) When the galvanometer has no deflections, with button K2 pressed, the T.G.T. reading is stabilised and can be read from the potentiometer main scale and the aircraft T.G.T. gauge.

(c) It is essential to repeat the instructions in para.2.A.(3)(c) and (d) at regular intervals to ensure that the galvanometer remains zeroed.

(2) Use Potentiometer R.R. type GZ.38989; refer to para.2.A.(3)(a) to (e).

(a) Select 1 or 2 on the left-hand rotary switch, depending on the input terminals being used.

(b) Select the OFF position on the right-hand rotary switch.

(c) Push the lever of the MEASURE/STANDARDISE switch to MEASURE and zero the galvanometer, using the main scale adjustment knob (clockwise moves the needle to the right).

(d) When the galvanometer has no deflections, with MEASURE selected, the T.G.T. reading is stabilised and can be read from the potentiometer main scale and the aircraft T.G.T. gauge.

(e) It is essential to repeat the instructions in para.2.A.(3)(c) and (d) at regular intervals to ensure that the galvanometer remains zeroed.

TABLE 5 (cont.)

ACTION	CHECK	ACCEPTANCE LIMITS	ACTION IF INCORRECT	RECTIFICATION, CALCULATIONS AND ILLUSTRATIONS
D. (cont.) RUN 2 (Re-installation run)	NOTE: When checking the torque pressure the O.I.T. should be as near as possible to the O.I.T. at which the mintorque was obtained during RUN 1 (Pre-removal run).			
Continue running engine at full throttle for a minimum of 4 minutes	Torque pressure; record observed pressure shown on aircraft and master torque pressure gauge; refer to para.2. A.(4). Record T.G.T.	Refer to 6. 'Calculate the new mintorque and torque pressure upper limit'. NOTE: This instruction is located immediately following TABLE 5		
	Oil inlet temperature and record same	Min. 85 degrees C. Max. 100 degrees C.	Refer to Section 4, 'ENGINE GROUND RUNNING PROCEDURES', para.8.c.	
If necessary, continue running engine at full throttle until T.G.T. has stabilized Min. 4 minutes Max. 5 minutes	Turbine gas temperature ***	Corrected datum T.G.T. (obtained in RUN 1) minus 5 degrees C. Refer to Sub-section 4E, 'CHARTS' for T.G.T. corrections.	Stop the engine	Refer to 'POWER PLANT - TROUBLE SHOOTING', T.G.T. faults (page block 101).
			Re-set the controls to obtain the correct T.G.T. then re-start the ground run at the commencement of Action D.	Refer to para.8., Re-set the engine controls.
		NOTE: After combustion chamber or flame tube changes, refer to RUN 1 for T.G.T. acceptance limits.	NOTE: Ensure that oil inlet temperature is below 70 degrees C. before re-commencing ground run.	
	Oil inlet temperature	120 degrees MAXIMUM		

TABLE 5 (cont.)

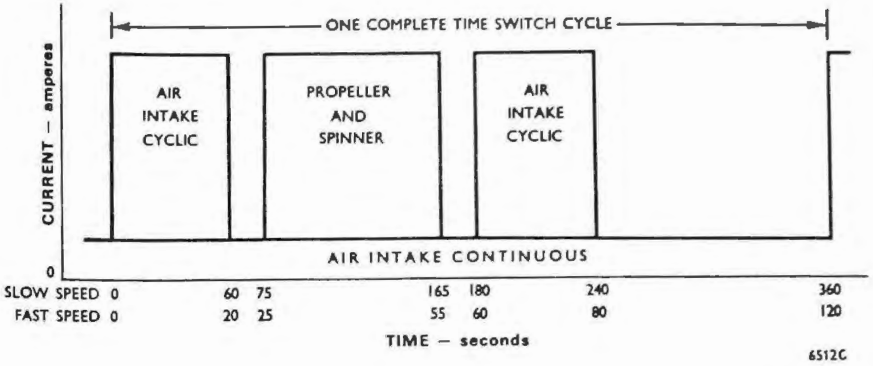
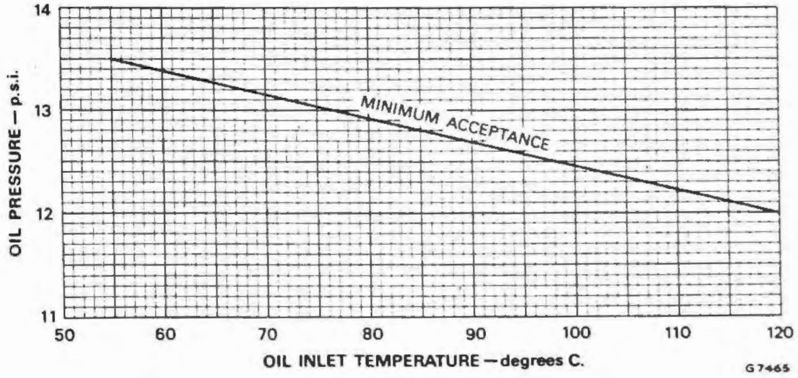
ACTION	CHECK	ACCEPTANCE LIMITS	ACTION IF INCORRECT	RECTIFICATION, CALCULATIONS AND ILLUSTRATIONS
NOTE: Action E.(1) is to check, if required, the power unit ice protection system; action E.(2) is to check the oil pressure.				
E. (1) Set the throttle to obtain 12,800 r.p.m.	Power unit ice protection system (only if required)	Refer to Fig.516	Refer to Chapter 30, 'ICE AND RAIN PROTECTION'	 Power unit ice protection system switch sequence Fig.516
(2) Set the throttle to obtain 12,000 r.p.m.	Oil inlet temperature	Minimum: 55 degrees C. Maximum: 120 degrees C.	Run to warm up	
	Oil pressure	Minimum: 13½ p.s.i. at 55 degrees C. and pro-rata down to 12 p.s.i at 120 degrees C. and above; refer to Fig.517 Maximum: 35 p.s.i. at any temperature If oil pressure is below minimum, run at maximum continuous r.p.m.; accept engine if oil pressure is not less than 13½ p.s.i. at 55 degrees C. and pro-rata down to 12 p.s.i. at 120 degrees C.	Stop the engine	Refer to 'POWER PLANT - TROUBLE SHOOTING', oil system defects (page block 101)  Minimum oil pressure limitation graph Fig.517

TABLE 5 (cont.)

ACTION	CHECK	ACCEPTANCE LIMITS	ACTION IF INCORRECT	RECTIFICATION, CALCULATION AND ILLUSTRATIONS
NOTE: Actions F. and G. are for checking the minimum constant speeding r.p.m. and the ground idling r.p.m.				
F. Set the FUEL DATUM to 50 per cent. Set the throttle to obtain 50 p.s.i. torque pressure, then vary the FUEL DATUM between 30 per cent and 70 per cent.	Minimum constant speeding r.p.m. (minimum governed speed)	R.p.m. must remain constant and must be within the following limits 10,850 and 11,150 r.p.m.	Stop the engine	Chap.61, 'PROPELLER CONTROLLER UNIT - MAINTENANCE PRACTICES'.
G. Close the throttle and set the FUEL DATUM as follows: For Mk.536-7P and 536-7R engines, 85 per cent. For all other engine Mks., 100 per cent.	Ground idling r.p.m.	Between 6,500 and 7,500 r.p.m.	Stop the engine	Refer to 'POWER PLANT - TROUBLE SHOOTING', r.p.m. faults (page block 101).
H. Proceed with wet ground run; refer to Sub-section 4B 'GROUND RUN - WET'.				

5. RUN 1 (pre-removal run): Establish the torque pressure margin above the Mintorque value

A. Correct the observed torque pressure to I.S.A. S.L. value.

(1) **Mk.528, 532, 536 and variants.**

(a) For pressure altitudes of 3,000 feet or less, refer to Fig.522, Sub-section 4E 'CHARTS'.

(b) For pressure altitudes of 3,000 feet to 10,000 feet, refer to Fig.524, Sub-section 4E 'CHARTS'.

(2) Mk.529 and variants.

(a) For pressure altitudes of 3,000 feet or less, refer to Fig.523, Sub-section 4E 'CHARTS'.

(b) For pressure altitudes of 3,000 feet to 10 000 feet, refer to Fig.525, Sub-section 4E 'CHARTS'.

(3) Mk.532-7P and 536-7P only.

(a) For pressure altitudes of 10,000 to 15,000 feet, refer to Fig.526, Sub-section 4E 'CHARTS'.

(4) If the outside air temperature is below 10 degrees C. a humidity correction is not required. If the outside air temperature is above 10 degrees C. obtain a humidity correction as follows.

(a) To obtain a humidity correction factor from graph E (Fig.522 to 526, Sub-section 4E 'CHARTS') read from the dew point scale to the required pressure altitude, then across to the left-hand axis. Show the resultant humidity correction factor as a short line at the correct value parallel to the existing humidity correction lines already drawn on graph B.

(5) To correct the observed torque pressure use the recorded ambient conditions, the observed torque pressure and the oil inlet temperature; refer to Fig.522 to 526, Sub-section 4E 'CHARTS'.

(a) Start at graph A, read from the outside air temperature scale to the required pressure altitude, then across to graph B to the humidity correction factor obtained in para.(4) (a). When a humidity correction factor is not required read to the zero humidity correction line.

(b) Read down from graph B to the observed pressure value on graph C; read across from this value to the left-hand vertical axis of graph D to obtain the corrected torque pressure; record this figure.

NOTE: The value of each small square on the left-hand vertical axis of graph D is 4 p.s.i.

B. Calculate the torque pressure margin

(1) Produce a graph similar to graph D on Fig.522 to 526, Sub-section 4E 'CHARTS' (do not include the lines shown only for example).

(2) On the prepared graph (using the previously recorded torque figures) mark the Mintorque and the torque pressure upper limit lines for 70 degrees C. oil inlet temperature on the left-hand vertical axis and the Mintorque and torque pressure upper limit lines for 100 degrees C. oil inlet temperature on the right-hand vertical axis.

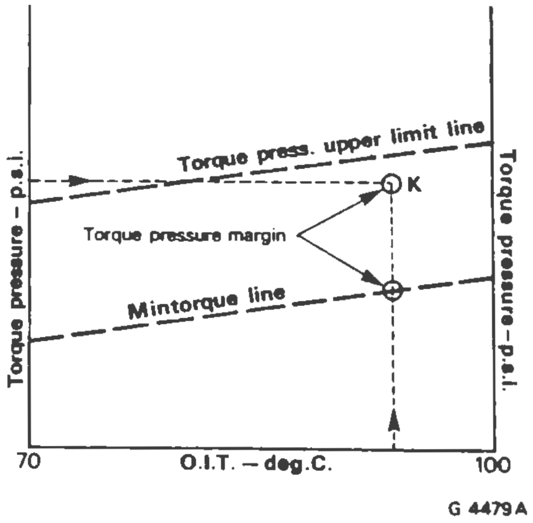
(3) Join the respective points to produce lines similar to those illustrated in the example (Fig.518).

(4) If an engine has Mintorque values declared but no torque pressure upper limit line values, proceed as follows:

(a) Subtract the Data-plate minimum turbine gas temperature from the Data-plate maximum turbine gas temperature and add 15 to the resultant value.

(Data-plate maximum T.G.T. - Data-plate minimum T.G.T.) + 15

NOTE: For the purpose of this calculation one degree C. of turbine gas temperature is equivalent to one p.s.i. of torque pressure.



Example of use of graph D
Fig.518

(b) Add the value obtained in para.(a) to the Mintorque values already recorded at 70 and 100 degrees C. oil inlet temperature to obtain the reference torque pressure upper limit values.

(5) Draw a horizontal line from the point on the left-hand vertical axis corresponding to the corrected torque pressure. Draw a vertical line from the point on the horizontal axis at the oil inlet temperature observed when the torque pressure was recorded during the ground run. Call the point of intersection 'K' (Fig.518).

(6) If the engine is acceptable for service (see C. Acceptance limits) calculate the torque pressure margin by subtracting the Mintorque from the corrected torque pressure (point 'K') at the same oil inlet temperature (Fig.518)

C. Acceptance limits

(1) If 'K' lies between the Mintorque line and the torque pressure upper limit line the engine is acceptable for service; if not, refer to 'POWER PLANT - TROUBLE SHOOTING', Torque pressure defects (page block 101).

CAUTION: DO NOT REDUCE THE FUEL FLOW IN ORDER TO BRING TORQUE PRESSURE BELOW THE TORQUE PRESSURE UPPER LIMIT LINE; REFER TO 'TROUBLE SHOOTING', PAGE BLOCK 101.

NOTE: Fuel flow may only be reduced in service to keep the dry Take-off turbine gas temperature within the maximum operating limit.

D. Documentation

(1) Record the following information in the engine log-book and appropriate aircraft documents.

(a) The Datum Turbine Gas Temperature, the oil inlet temperature and the Torque Pressure Margin (determined during RUN 1); for reference when the engine is re-installed.

6. RUN 2 (re-installation run): Calculate the new Mintorque and torque pressure upper limit

A. Correct the observed torque pressure to I.S.A. S.L. value.

(1) Mk.528, 532, 536 and variants.

(a) For pressure altitudes of 3,000 feet or less, refer to Fig.522, Sub-section 4E 'CHARTS'.

(b) For pressure altitudes of 3,000 feet to 10,000 feet, refer to Fig.524, Sub-section 4E 'CHARTS'.

(2) Mk.529 and variants

(a) For pressure altitudes of 3,000 feet or less, refer to Fig.523, Sub-section 4E 'CHARTS'.

(b) For pressure altitudes of 3,000 feet to 10,000 feet, refer to Fig.525, Sub-section 4E 'CHARTS'.

(3) Mk.532-7P and 536-7P only.

(a) For pressure altitudes of 10,000 to 15,000 feet, refer to Fig.526, Sub-section 4E 'CHARTS'.

(4) If the outside air temperature is below 10 degrees C. a humidity correction is not required. If the outside air temperature is above 10 degrees C. obtain a humidity correction as follows.

(a) To obtain a humidity correction factor from graph E (Fig.522 to 526, Sub-section 4E 'CHARTS') read from the dew point scale to the required pressure altitude, then across to the left-hand axis. Show the resultant humidity correction factor as a short line at the correct value parallel to the existing humidity correction lines already drawn on graph B.

(5) To correct the observed torque pressure use the recorded ambient conditions,the observed torque pressure and the oil inlet temperature; refer to Fig.522 to 526, Sub-section 4E 'CHARTS'.

NOTE: For each degree of T.G.T. that the engine is set below the Datum T.G.T. calculated from Run 1, add 1 p.s.i. to the observed torque pressure.

(a) Start at graph A, read from the outside air temperature scale to the required pressure altitude, then across to graph B to the humidity correction factor obtained in para.(4) (a). When a humidity correction factor is not required read to the zero humidity correction line.

(b) Read down from graph B to the observed torque pressure value on graph C; read across from this value to the left-hand vertical axis of graph D to obtain the corrected torque pressure; record this figure.

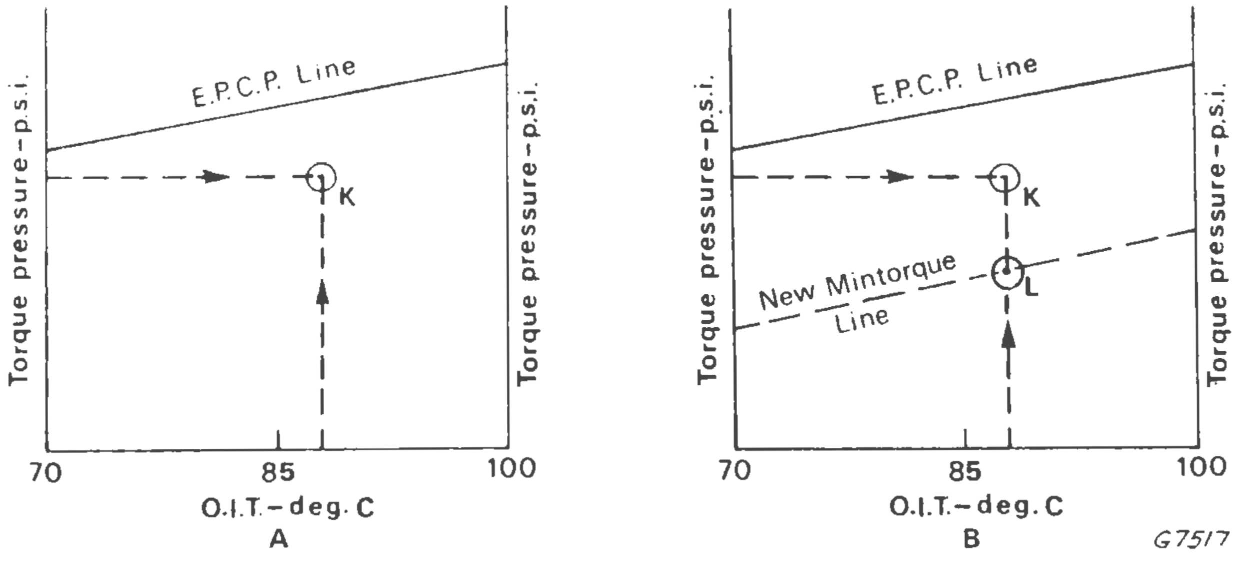
NOTE: The value of each small square on the left-hand vertical axis of graph D is 4 p.s.i.

B. Obtain a new Mintorque for the re-installed engine.

(1) Produce a graph similar to graph D on Fig.522 to 526, Sub-section 4E 'CHARTS' (do not include the lines shown only for example).

(2) On the prepared graph (using the previously recorded figures) mark the engine power check pressure (E.P.C.P.) for 70 degrees C. oil inlet temperature on the left-hand vertical axis and the E.P.C.P. for 100 degrees C. oil inlet temperature on the right-hand vertical axis. Join these two points to produce the engine power check pressure (E.P.C.P.) line as shown in Fig.519'A'.

(3) Draw a horizontal line from the point on the left-hand vertical axis corresponding to the corrected torque pressure. Draw a vertical line from the point on the horizontal axis at the oil inlet temperature observed when the torque pressure was recorded during the ground run. Call the point of intersection 'K' (Fig.519'A').



Example of use of graph D
Fig.519

Power plant - Adjustment/test (cont.)

(4) Establish the new Mintorque values.

(a) Subtract from the torque pressure value 'K' the torque pressure margin recorded in RUN 1 (pre-removal run) and plot this value as point 'L' vertically below point 'K'. Draw a line through point 'L' parallel to the E.P.C.P. line to obtain reference Mintorque values between oil inlet temperatures of 70 and 100 degrees C. (Fig.519'B').

C. Acceptance limits

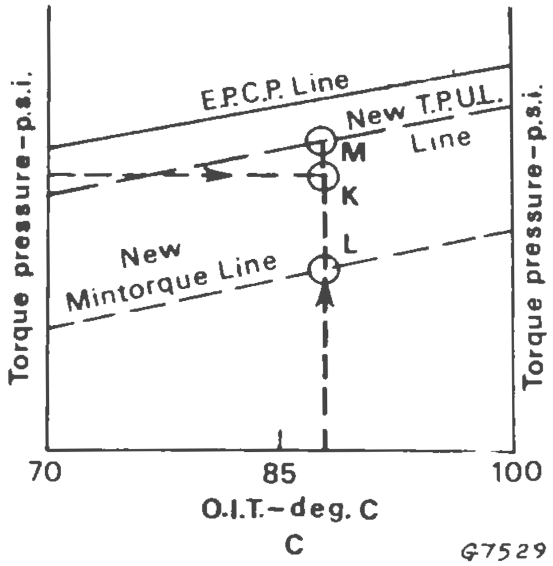
(1) If the Mintorque line lies between the E.P.C.P. line minus 15 p.s.i. and the E.P.C.P. line minus 60 p.s.i. the engine is acceptable for service. If not, refer to 'POWER PLANT - TROUBLE SHOOTING', Torque pressure defects' (page block 101).

D. Establish the new torque pressure upper limits.

(1) Subtract the Data-plate minimum turbine gas temperature from the Data-plate maximum turbine gas temperature and add 15 to the resultant value.

(Data-plate maximum T.G.T. - Data-plate minimum T.G.T.) + 15

NOTE: For the purpose of this calculation one degree C. of turbine gas temperature is equivalent to one p.s.i. of torque pressure.



Example of use of graph D
Fig.520

(2) Plot a point 'M' vertically above point 'L' equal to this value then draw a line through point 'M' parallel to the E.P.C.P. line to obtain reference T.P.U.L. values between 70 and 100 degrees C. oil inlet temperatures (Fig.520).

E. Subtract 25 p.s.i. from the Mintorque value at 70 degrees C. oil inlet temperature and placard the value obtained in the crew compartment.

NOTE: This value is the pilots' minimum 'dry' torque pressure limit, and when corrected for ambient conditions is used by the pilot to check 'dry' TAKE-OFF power.

7. Documentation

A. Record the following information in the engine log-book and appropriate aircraft documents.

(1) The Mintorque values at 70 and 100 degrees C. oil inlet temperature.

(2) The torque pressure upper limit values at 70 and 100 degrees C. oil inlet temperature.

(3) The oil inlet temperature at which point 'K' was recorded; refer to para.6.B.(3).

(4) Pilot's minimum 'dry' torque pressure value.

8. Re-set the engine controls (Fig.521)

NOTE: To ensure consistent results always set the fuel datum position indicator from a lower value.

A. Re-set the controls if there is sufficient adjustment on the control box adjustable stop.

(1) Re-set the controls to obtain the required turbine gas temperature.

(a) Open the pilot's throttle lever fully and set the FUEL DATUM position indicator to FULL INCREASE (100 per cent) for all engine Mks.

(b) Adjust the rod length (5) between the throttle valve lever (2) and the engine control box to obtain the required turbine gas temperature, adjusting the fuel control unit maximum stop (1) to obtain not less than 0.050 in. clearance.

NOTE: One sixth of a turn of the rod (5) anti-clockwise (viewed from the rear of the engine) increases the turbine gas temperature approximately 3 degrees C.

(c) Close the pilots' throttle lever fully and set the FUEL DATUM position indicator to:

Mk.536-7P, 536-7R and 535-7 - 85 per cent

All other Mks. - 100 per cent

(d) Adjust the engine control box adjustable stop (8), (with the throttle pick-up lever (6), contacting it) to obtain a clearance between the throttle valve lever (2) and the fuel control unit minimum stop (3) of:

Modification standard	Minimum stop (3) clearance	Adjustable stop (8) projection limits
Pre-Mod.1138	0.100 in.	0.0 in. to 0.100 in.
Mod.1138 (S.B.Da72-151) but pre-Mod.1523	0.120 in.	0.0 in. to 0.175 in.
Mod.1523 (S.B.Da73-55)	0.140 in.	0.0 in. to 0.225 in.

(2) If permissible adjustment is insufficient, re-set the throttle valve lever as instructed in para.B.

B. Re-set the controls if there is insufficient adjustment on the control box adjustable stop

(1) Set a datum position for maximum Take-off fuel flow.

(a) Open the pilot's throttle lever fully and set the FUEL DATUM position indicator to:

Mk.536-7P, 536-7R and 535-7 - 85 per cent

All other Mks. - 100 per cent

(b) To provide the datum position, adjust the fuel control unit maximum stop (1) to just contact the throttle valve lever (2) ensuring that the throttle pick-up lever (6) contacts the engine control box maximum stop (7).

(2) Re-set the controls box adjustable stop to mid-travel.

(a) Set the controls box adjustable stop (8) projection to:

Pre-Mod.1138	0.050 in.
Mod.1138 (S.B.Da72-151) but pre-Mod.1523	0.090 in.
Mod.1523 (S.B.Da73-55)	0.110 in.

(b) Close the pilot's throttle lever fully, retaining the FUEL DATUM position previously set in para.B. (1)(a) and ensure that the throttle pick-up lever (6) contacts the engine control box adjustable stop (8).

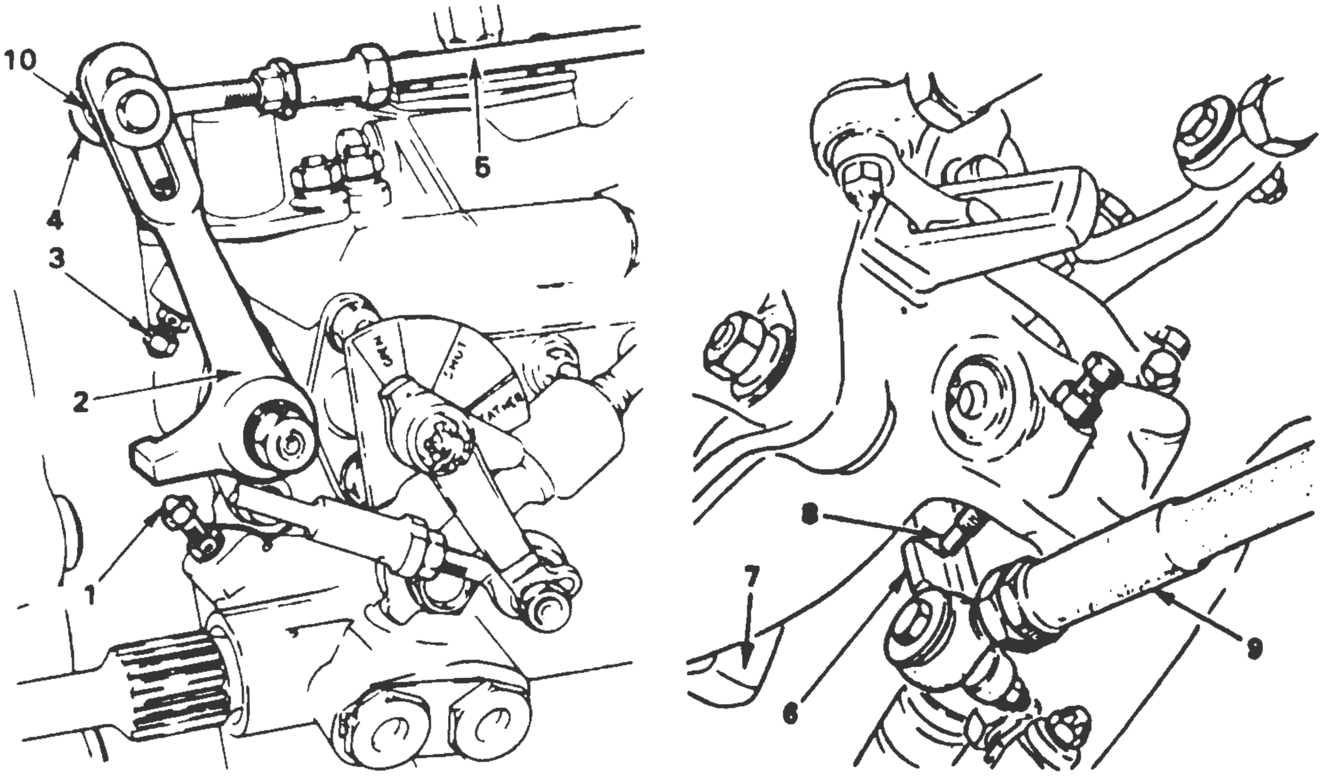
(3) Re-set the throttle valve lever travel.

(a) Measure the clearance between the throttle valve lever (2) and the fuel control unit minimum stop (3).

(b) Re-position the throttle valve lever end-coupling (4) one serration inwards for every 0.020 in. that the clearance between the throttle valve lever (2) and the fuel control unit minimum stop (3) exceeds the following dimensions:

Pre-Mod.1138	0.100 in.
Mod.1138 (S.B.Da72-151) but pre-Mod.1523	0.120 in.
Mod.1523 (S.B.Da73-55)	0.140 in.

NOTE: An adjustment of 0.010 in. can be obtained by rotating the serrated washer (10) situated between the end-coupling (4) and the throttle valve lever (2), through 180 degrees.



FUEL CONTROL UNIT

ENGINE CONTROL BOX

1. FUEL CONTROL UNIT MAXIMUM STOP.
2. FUEL CONTROL UNIT THROTTLE VALVE LEVER.
3. FUEL CONTROL UNIT MINIMUM STOP.
4. THROTTLE VALVE LEVER CONTROL ROD END-COUPLING.
5. THROTTLE VALVE LEVER CONTROL ROD.
6. ENGINE CONTROL BOX THROTTLE PICK-UP LEVER.
7. ENGINE CONTROL BOX MAXIMUM (FIXED) STOP.
8. ENGINE CONTROL BOX ADJUSTABLE STOP.
9. AIRCRAFT CONTROL ROD.
10. SERRATED WASHER.

G7542

Control adjustments
Fig.521

(4) Restore the throttle valve lever clearances

(a) Open the pilot's throttle lever fully, retaining the FUEL DATUM position previously set in para.B.(1)(a).

(b) Adjust the control rod (5) length between the throttle valve lever (2) and the engine control box until the throttle valve lever (2) just contacts the fuel control unit maximum stop (1).

(c) Still retaining the FUEL DATUM position previously set, close the pilot's throttle lever fully and ensure that the throttle pick-up lever (6) contacts the engine control box adjustable stop (8).

(d) Adjust the engine control box adjustable stop (8) projection, within the permissible limits, to obtain a clearance between the throttle valve lever (2) and the fuel control unit minimum stop (3) of:

Modification standard	Minimum stop (3) clearance	Adjustable stop (8) projection limits
Pre-Mod.1138	0.100 in.	0.0 in. to 0.100 in.
Mod.1138 (S.B.Da72-151) but pre-Mod.1523	0.120 in.	0.0 in. to 0.175 in.
Mod.1523 (S.B.Da73-55)	0.140 in.	0.0 in. to 0.225 in.

(e) Set the FUEL DATUM position indicator to FULL INCREASE (100 per cent) for all engine Mks.

(f) Open the pilot's throttle lever fully, then adjust the fuel control unit maximum stop (1) to obtain a minimum clearance of 0.050 in. between it and the throttle valve lever (2).

C. Adjust the turbine gas temperature (alternative method)

NOTE: The fuel trim switches are used to adjust the maximum fuel flow and so obtain the desired turbine gas temperature; this limits the use of this method, when near or below I.S.A. conditions, to adjusting for high turbine gas temperature.

(1) Adjust the control rod length (5) to obtain the required maximum turbine gas temperature.

(a) Use the fuel trim switches to reduce the turbine gas temperature below the required value (if necessary), then increase the fuel trim until the required turbine gas temperature indication has stabilized.

(b) Stop the engine without altering the FUEL DATUM setting.

(c) Open the pilot's throttle lever fully (FUEL DATUM setting still unaltered) and ensure that the throttle pick-up lever (6) contacts the engine control box maximum stop (7).

(d) Measure and note the clearance between the fuel control unit maximum stop (1) and the throttle valve lever (2).

(e) Restore the FUEL DATUM to the original setting; refer to 4. 'Ground run sequence', ACTION B.

(f) Adjust the control rod length (5) between the throttle valve lever (2) and the engine control box to give the fuel control unit maximum stop/throttle valve lever clearance obtained in para.(d) above.

(g) Set the FUEL DATUM to full INCREASE (100 per cent) and adjust the fuel control unit maximum stop (1) to obtain a minimum clearance of 0.050 in. between it and the throttle valve lever (2).

(2) Obtain the fuel control unit minimum stop (3) clearance

(a) Close the pilots' throttle lever fully and set the FUEL DATUM position indicator to:

Mk.536-7P, 536-7R and 535-7	-	85 per cent
All other Mks.	-	100 per cent

(b) Adjust the engine control box adjustable stop (8), (with the throttle pick-up lever (6) contacting it) to obtain a clearance between the throttle valve lever (2) and the fuel control unit minimum stop (3) of:

Modification standard	Minimum stop (3) clearance	Adjustable stop (8) projection limits
Pre-Mod.1138	0.100 in.	0.0 in. to 0.100 in.
Mod.1138 (S.B.Da72-151) but pre-Mod.1523	0.120 in.	0.0 in. to 0.175 in.
Mod.1523 (S.B.Da73-55)	0.140 in.	0.0 in. to 0.225 in.

(c) If permissible adjustment is insufficient, re-set the throttle valve lever as instructed in para.B.

(d) Check the engine controls for full and free movement; refer to Chap.76-0, 'MAINTENANCE PRACTICES - ENGINE CONTROLS', SERVICING.

(3) Carry out the controls static checks as instructed in Chap.76-0, 'MAINTENANCE PRACTICES - ENGINE CONTROLS', STATIC CHECKS AND ADJUSTMENTS.

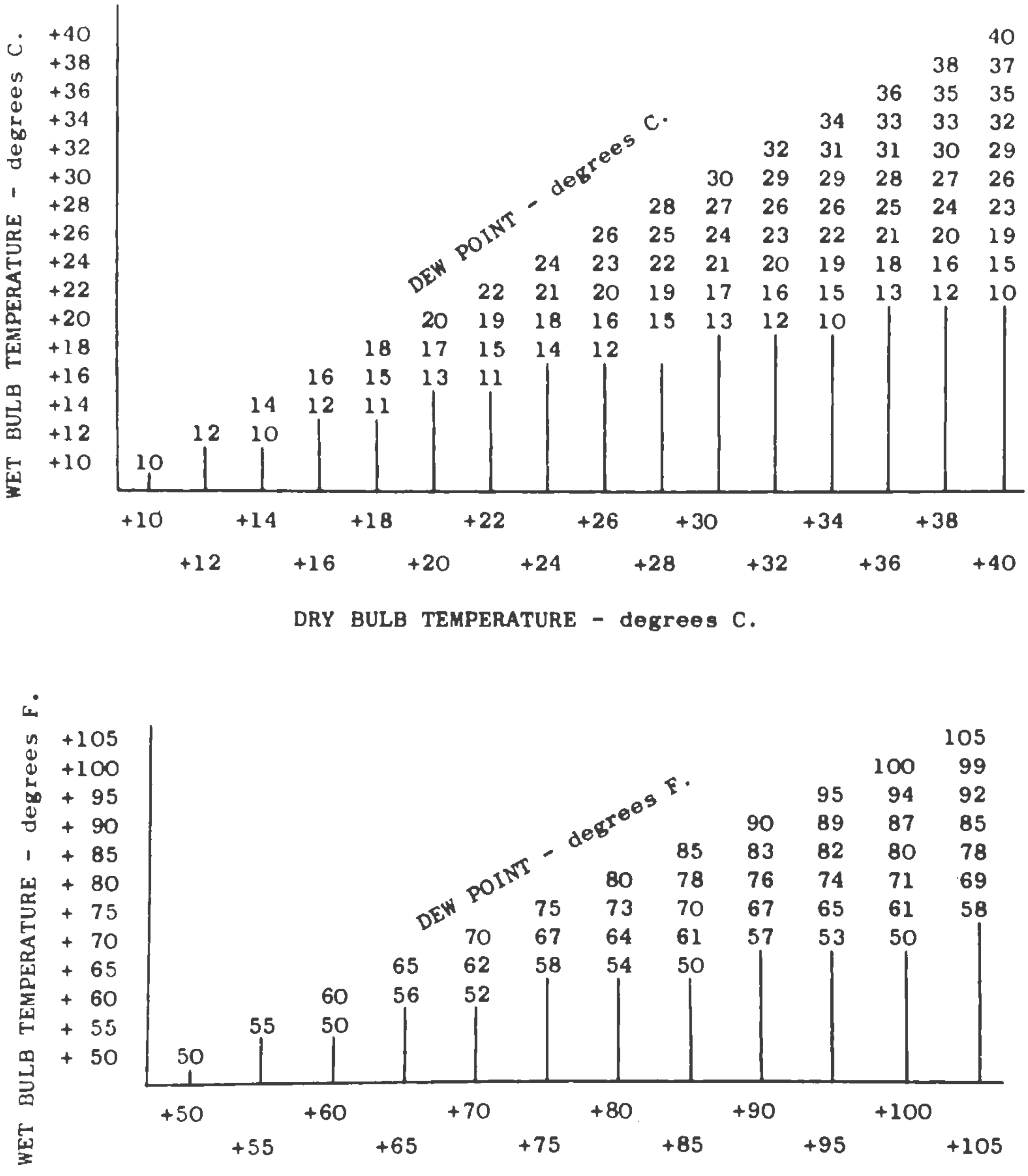
(4) On satisfactory completion of the controls static checks re-start the ground run at the commencement of ACTION D.

CHARTS

1. General

A. This section contains all the charts required to obtain the corrections for variations from I.S.A. S.L. conditions and must be used in conjunction with the relevant ground run.

Power plant - Adjustment/test (cont.)



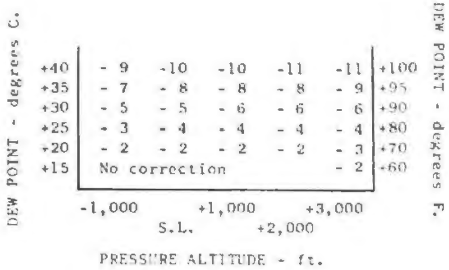
G3537

Conversion to dew point (degrees C./degrees F.) chart

CHART 1

Apply the dew point factor obtained from the appropriate chart to CHART 1A if a humidity correction to the fuel datum setting is required, and to graph E in the torque pressure correction graphs when correcting the observed torque pressure for humidity.

Power plant - Adjustment/test (cont.)

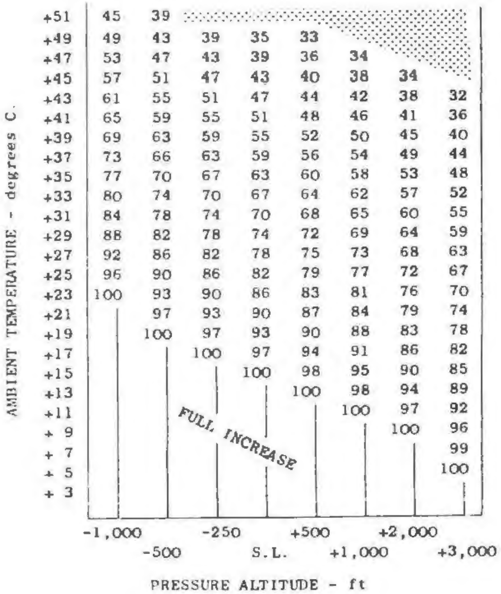


DEW POINT - degrees C.	-1,000	S.L.	+1,000	+2,000	+3,000	DEW POINT - degrees F.
+40	- 9	-10	-10	-11	-11	+100
+35	- 7	- 8	- 8	- 8	- 9	+95
+30	- 5	- 5	- 6	- 6	- 6	+90
+25	- 3	- 4	- 4	- 4	- 4	+80
+20	- 2	- 2	- 2	- 2	- 3	+70
+15	No correction				- 2	+60

G3532

Fuel datum setting change for
humidity chart
CHART 1A

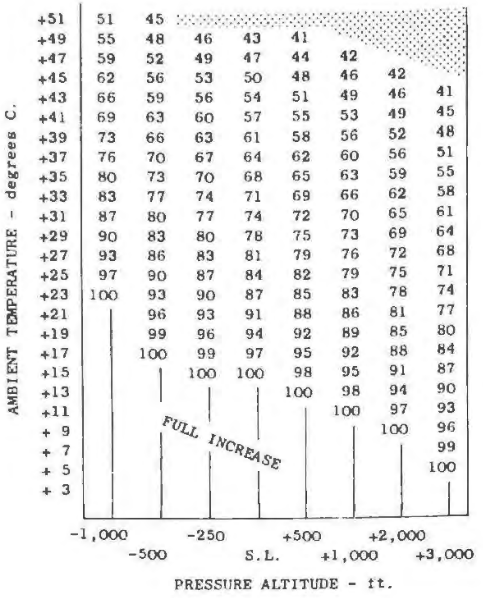
Subtract the factor obtained from CHART 1A from the appropriate fuel datum chart.



AMBIENT TEMPERATURE - degrees C.	-1,000	-500	-250	S.L.	+500	+1,000	+2,000	+3,000
+51	45	39						
+49	49	43	39	35	33			
+47	53	47	43	39	36	34		
+45	57	51	47	43	40	38	34	
+43	61	55	51	47	44	42	38	32
+41	65	59	55	51	48	46	41	36
+39	69	63	59	55	52	50	45	40
+37	73	66	63	59	56	54	49	44
+35	77	70	67	63	60	58	53	48
+33	80	74	70	67	64	62	57	52
+31	84	78	74	70	68	65	60	55
+29	88	82	78	74	72	69	64	59
+27	92	86	82	78	75	73	68	63
+25	96	90	86	82	79	77	72	67
+23	100	93	90	86	83	81	76	70
+21		97	93	90	87	84	79	74
+19		100	97	93	90	88	83	78
+17			100	97	94	91	86	82
+15				100	98	95	90	85
+13					100	98	94	89
+11						100	97	92
+ 9							100	96
+ 7								99
+ 5								100
+ 3								

G3533

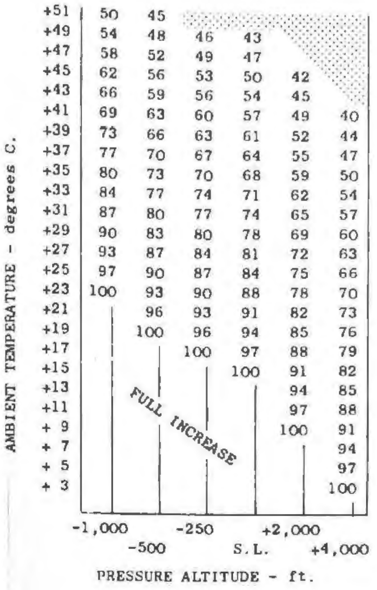
Fuel datum setting chart: pre-Mod.1371
CHART 1B



AMBIENT TEMPERATURE - degrees C.	-1,000	-500	-250	S.L.	+500	+1,000	+2,000	+3,000
+51	51	45						
+49	55	48	46	43	41			
+47	59	52	49	47	44	42		
+45	62	56	53	50	48	46	42	
+43	66	59	56	54	51	49	46	41
+41	69	63	60	57	55	53	49	45
+39	73	66	63	61	58	56	52	48
+37	76	70	67	64	62	60	56	51
+35	80	73	70	68	65	63	59	55
+33	83	77	74	71	69	66	62	58
+31	87	80	77	74	72	70	65	61
+29	90	83	80	78	75	73	69	64
+27	93	86	83	81	79	76	72	68
+25	97	90	87	84	82	79	75	71
+23	100	93	90	87	85	83	78	74
+21		96	93	91	88	86	81	77
+19		99	96	94	92	89	85	80
+17		100	99	97	95	92	88	84
+15			100	100	98	95	91	87
+13					100	98	94	90
+11						100	97	93
+ 9							100	96
+ 7								99
+ 5								100
+ 3								

G3534

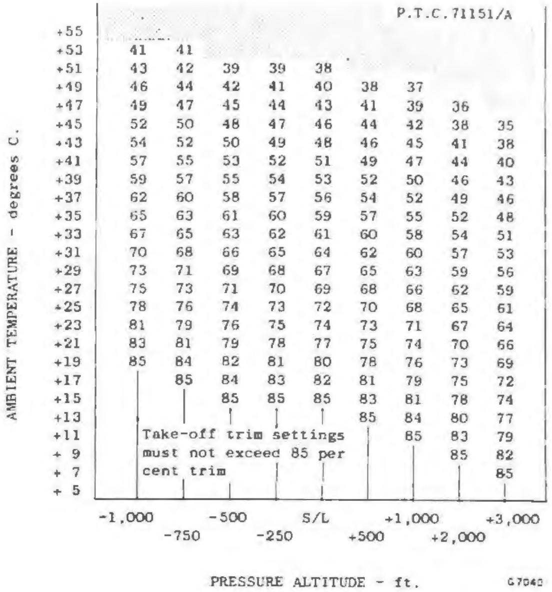
Fuel datum setting chart: Mod.1371
CHART 1C



AMBIENT TEMPERATURE - degrees C.	-1,000	-500	-250	S.L.	+2,000	+4,000
+51	50	45				
+49	54	48	46	43		
+47	58	52	49	47		
+45	62	56	53	50	42	
+43	66	59	56	54	45	
+41	69	63	60	57	49	40
+39	73	66	63	61	52	44
+37	77	70	67	64	55	47
+35	80	73	70	68	59	50
+33	84	77	74	71	62	54
+31	87	80	77	74	65	57
+29	90	83	80	78	69	60
+27	93	87	84	81	72	63
+25	97	90	87	84	75	66
+23	100	93	90	88	78	70
+21		96	93	91	82	73
+19		100	96	94	85	76
+17			100	97	88	79
+15				100	91	82
+13					94	85
+11					97	88
+ 9					100	91
+ 7						94
+ 5						97
+ 3						100

G3535

Fuel datum setting chart: Mk.532-7N
and 532-7P (Mod.1371)
CHART 1D



AMBIENT TEMPERATURE - degrees C.	-1,000	-750	-500	-250	S/L	+500	+1,000	+2,000	+3,000
+55									
+53	41	41							
+51	43	42	39	39	38				
+49	46	44	42	41	40	38	37		
+47	49	47	45	44	43	41	39	36	
+45	52	50	48	47	46	44	42	38	35
+43	54	52	50	49	48	46	45	41	38
+41	57	55	53	52	51	49	47	44	40
+39	59	57	55	54	53	52	50	46	43
+37	62	60	58	57	56	54	52	49	46
+35	65	63	61	60	59	57	55	52	48
+33	67	65	63	62	61	60	58	54	51
+31	70	68	66	65	64	62	60	57	53
+29	73	71	69	68	67	65	63	59	56
+27	75	73	71	70	69	68	66	62	59
+25	78	76	74	73	72	70	68	65	61
+23	81	79	76	75	74	73	71	67	64
+21	83	81	79	78	77	75	74	70	66
+19	85	84	82	81	80	78	76	73	69
+17		85	84	83	82	81	79	75	72
+15			85	85	85	83	81	78	74
+13						85	84	80	77
+11							85	83	79
+ 9								85	82
+ 7									85
+ 5									

G7040

Fuel datum setting chart:
Mk.536-7P and 536-7R
CHART 1E

1. Use Chart 1D for ground runs at pressure altitude between -500 and + 4,000 ft. for Mk.532-7N and 532-7P engines.

2. Use Chart 1E for ground runs at pressure altitude between -500 and + 3,000 ft. for Mk.536-7P and 536-7R engines.

3. Use Charts 1B and 1C for ground runs at pressure altitude between -500 and + 3,000 ft. for other engine Mks.

4. Do not carry out power checks at ambient conditions in excess of I.S.A. + 35 degrees C.

Ground running
corrections for ambient conditions
CHARTS 1A, 1B, 1C, 1D and 1E

Power plant - Adjustment/test (cont.)

Use chart 1F for ground-runs at pressure altitude between -500 and +3,000 ft.

Do not carry out power checks at ambient conditions in excess of I.S.A. + 35 degrees C.

AMBIENT TEMPERATURE - degrees C.	-1,000	-500	-250	S.L.	+500	+1,000	+2,000	+3,000
+21	3							
+19	9			NO CORRECTION				
+17	15	0						
+15	22	6	2	0				
+13	28	12	8	6	2			
+11	34	18	14	12	7	4		
+ 9	40	23	20	17	13	9	1	
+ 7	46	29	26	23	19	15	6	0
+ 5	52	35	32	29	24	20	12	4
+ 3	58	41	37	34	30	26	17	9
+ 1	65	47	43	40	36	31	23	15
- 1	71	53	49	46	41	37	28	20
- 3	77	58	55	52	47	42	33	25
- 5	83	64	61	58	53	48	38	30
- 7	89	70	67	63	58	53	44	35
- 9	95	76	72	69	64	59	49	40
-11	101	82	78	75	70	64	54	45
-13	108	88	84	80	75	70	60	51
-15	114	94	90	86	81	76	65	56
-17	120	100	96	92	87	81	71	61
-19	126	105	102	98	92	87	76	66
-21	132	111	107	103	98	92	82	72
-23	138	117	113	109	104	98	87	77
-25	145	123	119	115	109	103	92	82
-27	151	129	125	120	115	109	97	87
-29	157	135	131	126	121	115	103	92
-31	163	141	136	132	126	120	108	97
-33	169	147	142	138	132	126	113	103
-35	175	153	148	144	137	131	119	108
-37	182	158	154	149	143	137	124	113
-39	188	164	160	155	148	142	129	119

PRESSURE ALTITUDE - ft. G7320

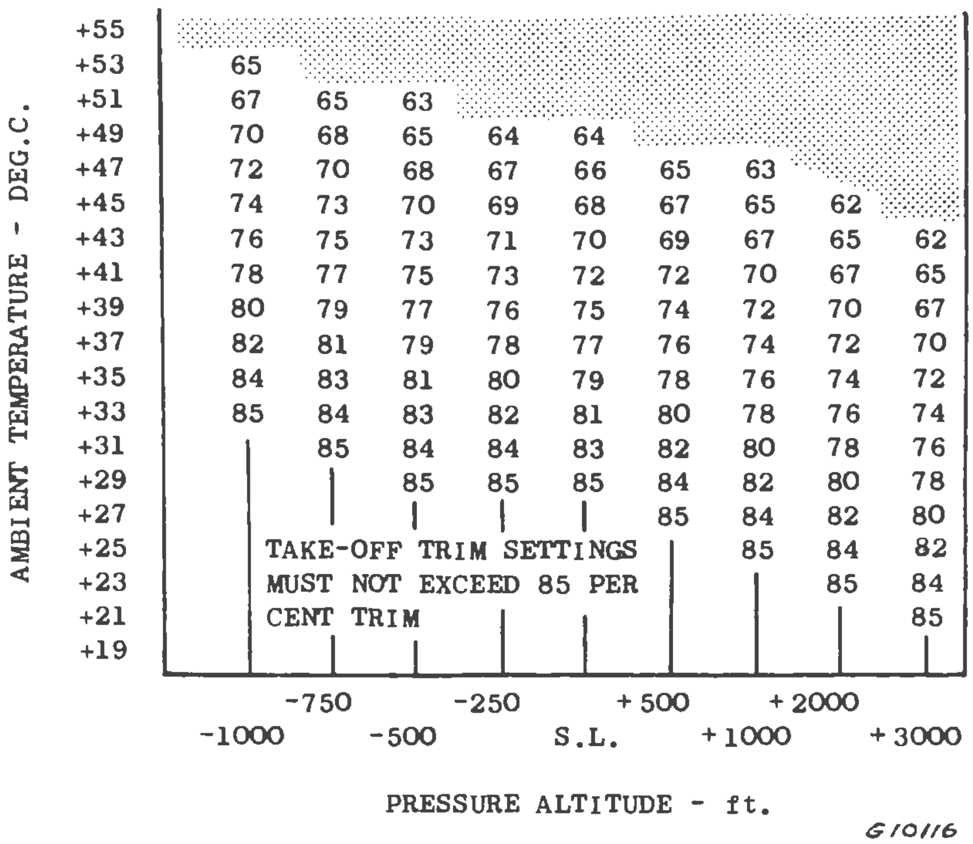
Turbine gas temperature correction chart
CHART 1F

Subtract above correction from the Data-plate maximum or minimum turbine gas temperature or Operating limitations maximum turbine gas temperature at Take-off r.p.m. as appropriate.

To obtain the Datum T.G.T. (pre-removal run, RUN 1 in Sub-section 4D 'REMOVAL/ RE-INSTALLATION GROUND RUN - DRY'). ADD the T.G.T. correction to the observed value.

NOTE: This is the only occasion when the correction is ADDED to the T.G.T.

Power plant - Adjustment/test (cont.)

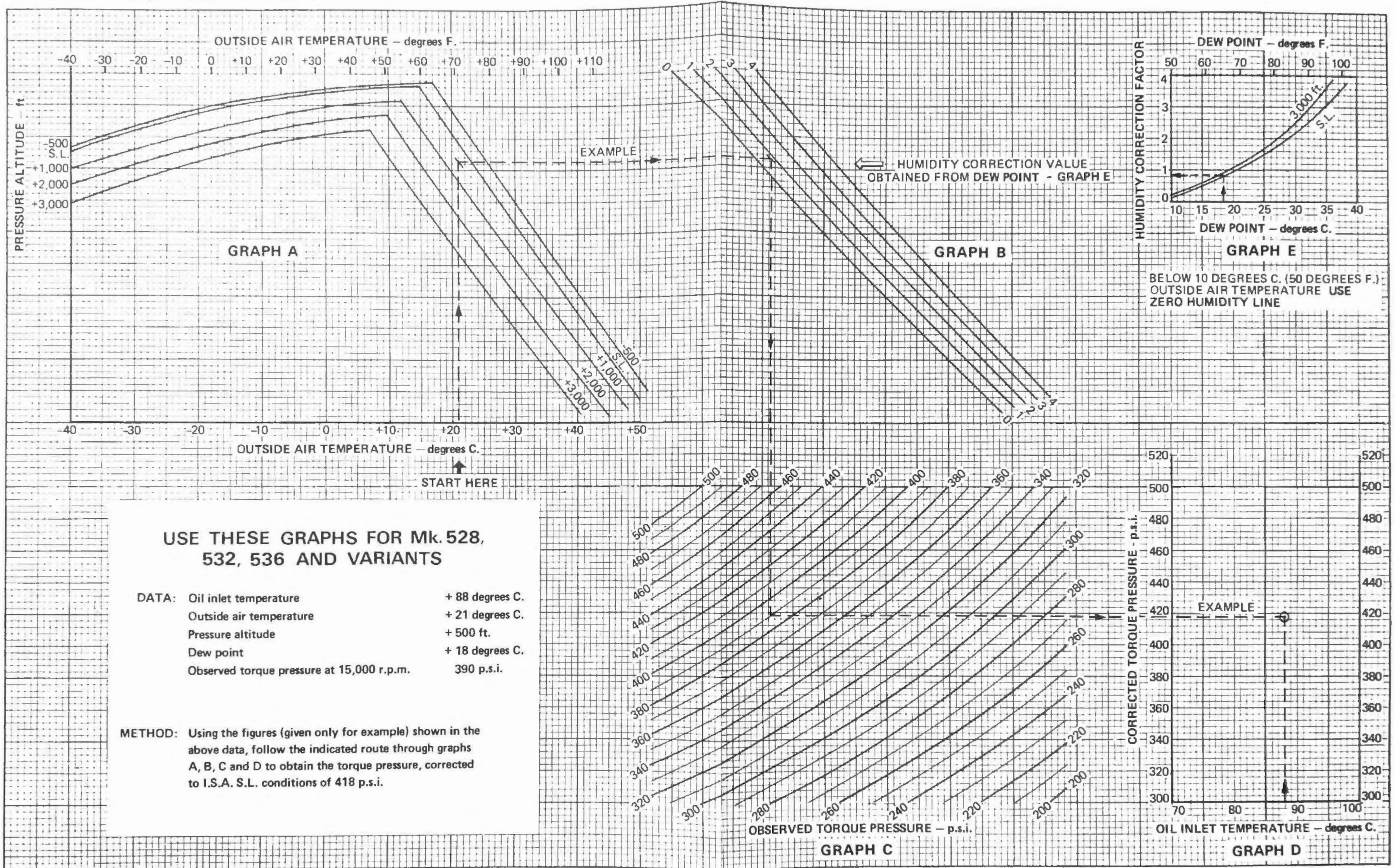


AMBIENT TEMPERATURE - DEG.C.	-1000	-750	-500	-250	S.L.	+500	+1000	+2000	+3000
+55									
+53	65								
+51	67	65	63						
+49	70	68	65	64	64				
+47	72	70	68	67	66	65	63		
+45	74	73	70	69	68	67	65	62	
+43	76	75	73	71	70	69	67	65	62
+41	78	77	75	73	72	72	70	67	65
+39	80	79	77	76	75	74	72	70	67
+37	82	81	79	78	77	76	74	72	70
+35	84	83	81	80	79	78	76	74	72
+33	85	84	83	82	81	80	78	76	74
+31		85	84	84	83	82	80	78	76
+29			85	85	85	84	82	80	78
+27						85	84	82	80
+25							85	84	82
+23								85	84
+21									85
+19									

Fuel datum setting chart
Mk.551-7 and 551-7R
CHART 1G

1. Use Chart 1G for ground runs at pressure altitude between -500 and +3,000 ft. for Mk.551-7 and Mk.551-7R engines.

2. Do not carry out power checks at ambient conditions in excess of I.S.A. +35 degrees C.



USE THESE GRAPHS FOR Mk. 528, 532, 536 AND VARIANTS

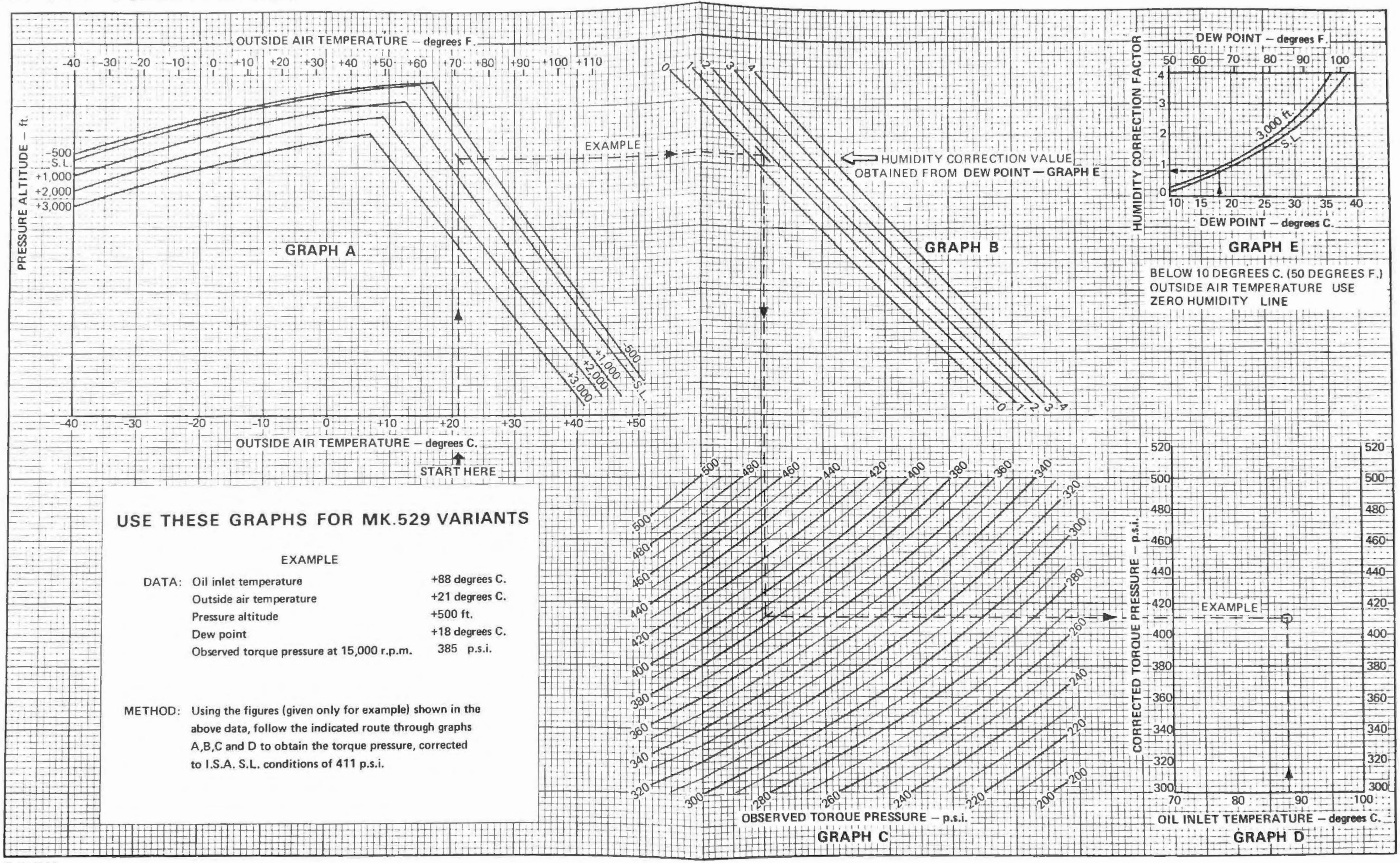
DATA:		
	Oil inlet temperature	+ 88 degrees C.
	Outside air temperature	+ 21 degrees C.
	Pressure altitude	+ 500 ft.
	Dew point	+ 18 degrees C.
	Observed torque pressure at 15,000 r.p.m.	390 p.s.i.

METHOD: Using the figures (given only for example) shown in the above data, follow the indicated route through graphs A, B, C and D to obtain the torque pressure, corrected to I.S.A. S.L. conditions of 418 p.s.i.

G3500B

Torque pressure correction graphs
for pressure altitudes of -500 to +3,000 ft.
Fig.522

Power plant - Adjustment/test (cont.)



USE THESE GRAPHS FOR MK.529 VARIANTS

EXAMPLE

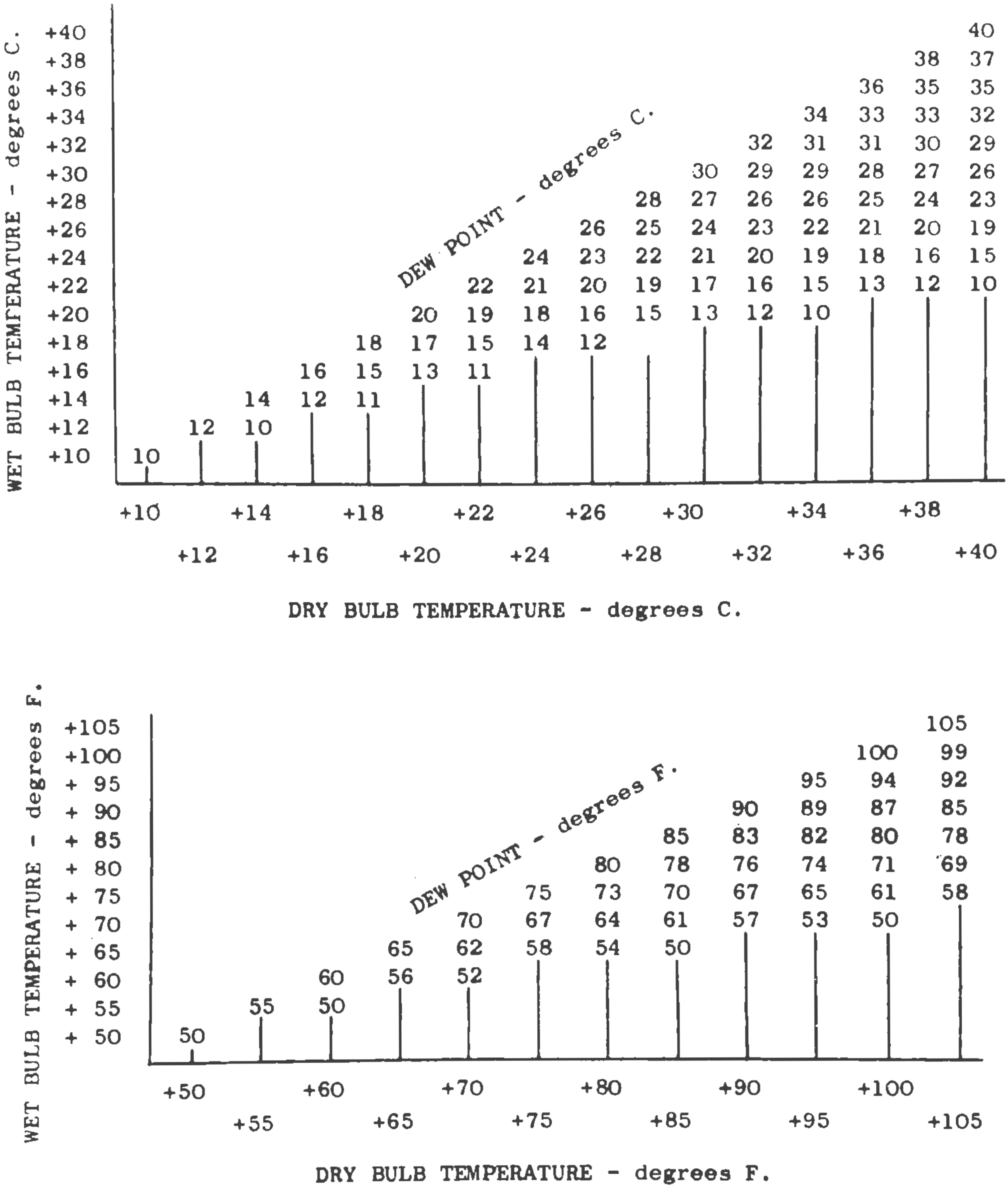
DATA:		
	Oil inlet temperature	+88 degrees C.
	Outside air temperature	+21 degrees C.
	Pressure altitude	+500 ft.
	Dew point	+18 degrees C.
	Observed torque pressure at 15,000 r.p.m.	385 p.s.i.

METHOD: Using the figures (given only for example) shown in the above data, follow the indicated route through graphs A,B,C and D to obtain the torque pressure, corrected to I.S.A. S.L. conditions of 411 p.s.i.

BELOW 10 DEGREES C. (50 DEGREES F.) OUTSIDE AIR TEMPERATURE USE ZERO HUMIDITY LINE

G 3767A

Torque pressure correction graphs
for pressure altitudes of -500 to +3,000 ft.
Fig.523



G3537

Conversion to dew point (degrees C./degrees F.) chart
CHART 2

Apply the dew point factor obtained from the appropriate chart to CHART 2A if a humidity correction to the fuel datum setting is required, and to graph E in the torque pressure correction graphs when correcting the observed torque pressure for humidity.

Power plant - Adjustment/test (cont.)

DEW POINT - degrees C.	+3,000	+4,000	+5,000	+6,000	+7,000	+8,000	+9,000	+10,000	DEW POINT - degrees F.
+40	-11	-11	-12	-12	-13	-13	-13	-14	+100
+35	- 9	- 9	-10	-10	-10	-11	-11	-12	+95
+30	- 6	- 6	- 7	- 7	- 7	- 8	- 8	- 8	+90
+25	- 4	- 4	- 5	- 5	- 5	- 5	- 6	- 6	+80
+20	- 3	- 3	- 3	- 3	- 3	- 4	- 4	- 4	+70
+15	- 2	- 2	- 2	- 2	- 2	- 2	- 2	- 2	+60

PRESSURE ALTITUDE - ft.

G3538

Fuel datum setting change for
humidity chart
CHART 2A

Subtract the factor obtained from CHART 2A from the appropriate fuel datum chart.

AMBIENT TEMPERATURE - degrees C.	+3,000	+4,000	+5,000	+6,000	+7,000	+8,000	+9,000	+10,000
+51								
+49								
+47								
+45								
+43	32							
+41	36	32						
+39	40	36	31					
+37	44	39	35	30				
+35	48	43	39	34	29			
+33	52	47	42	37	33	29		
+31	55	50	46	41	37	32	28	
+29	59	54	50	45	40	36	31	27
+27	63	58	53	48	44	39	35	30
+25	67	62	57	52	47	43	38	34
+23	70	65	60	56	51	46	42	37
+21	74	69	64	59	54	50	45	40
+19	78	73	68	63	58	53	48	44
+17	82	76	71	66	61	57	52	47
+15	85	80	75	70	65	60	55	50
+13	89	84	78	73	68	64	58	54
+11	92	87	82	77	71	67	62	57
+ 9	96	90	85	80	75	70	65	60
+ 7	99	94	89	84	78	74	69	64
+ 5	100	97	92	87	82	77	72	67
+ 3		100	95	90	85	81	75	70
+ 1			99	94	88	84	79	74
- 1			100	97	91	87	82	77
- 3				100	95	90	85	80
- 5					98	94	88	83
- 7					100	97	92	87
- 9						100	95	90
-11							98	93
-13							100	96
-15								99
-17								100

FULL INCREASE

PRESSURE ALTITUDE - ft.

G3539

Fuel datum setting chart: pre-Mod.1371
CHART 2B

AMBIENT TEMPERATURE - degrees C.	+3,000	+4,000	5,000	+6,000	+7,000	+8,000	+9,000	+10,000
+51								
+49								
+47								
+45								
+43	41							
+41	45	40						
+39	48	44	39					
+37	51	47	43	39				
+35	55	50	46	42	38			
+33	58	53	49	45	41	38		
+31	61	57	52	48	44	41	36	
+29	64	60	56	51	48	44	39	36
+27	68	63	59	55	51	47	43	39
+25	71	66	62	58	54	50	46	42
+23	74	69	65	61	57	53	49	45
+21	77	73	68	64	60	55	52	48
+19	80	76	71	67	63	59	55	51
+17	84	79	74	70	66	62	58	54
+15	87	82	77	73	69	65	61	57
+13	90	85	80	76	72	68	64	60
+11	93	88	83	79	75	71	67	62
+ 9	96	91	86	82	78	74	69	65
+ 7	99	94	90	85	81	77	72	68
+ 5	100	97	93	88	84	80	75	71
+ 3		100	95	91	87	83	78	74
+ 1			98	94	90	85	81	77
- 1			100	97	93	88	84	80
- 3				100	96	91	87	82
- 5					99	94	90	85
- 7					100	97	93	88
- 9						100	96	91
-11							98	94
-13							100	96
-15								99
-17								100

FULL INCREASE

PRESSURE ALTITUDE - ft.

G3540

Fuel datum setting chart: Mod.1371
CHART 2C

AMBIENT TEMPERATURE - degrees C.	+4,000	+6,000	+8,000	+10,000	+12,000	+14,000	+15,000
+41	40						
+39	44						
+37	47	39					
+35	50	42					
+33	54	45	38				
+31	57	48	41				
+29	60	51	44	36			
+27	63	55	47	39			
+25	66	58	50	42	33		
+23	70	61	53	45	36		
+21	73	64	56	48	39	34	
+19	76	67	59	51	42	38	36
+17	79	70	62	54	45	41	39
+15	82	73	65	57	48	44	42
+13	85	76	68	60	51	47	45
+11	88	79	71	62	54	50	47
+ 9	91	82	74	65	58	53	50
+ 7	94	85	77	68	60	56	53
+ 5	97	88	80	71	63	59	56
+ 3	100	91	83	74	66	62	59
+ 1		94	86	77	69	64	62
- 1		97	89	80	72	67	65
- 3		100	91	83	75	70	67
- 5			94	85	77	73	70
- 7			97	88	81	76	73
- 9			100	91	83	79	75
-11				93	86	81	78
-13				96	89	84	81
-15				99	92	86	83
-17				100	94	89	86
-19					97	92	88
-21					100	94	91
-23						97	94
-25						99	96
-27						100	98
-29							100

FULL INCREASE

PRESSURE ALTITUDE - ft.

G3541

Fuel datum setting chart: Mk.532-7N
and 532-7P (Mod.1371)
CHART 2D

AMBIENT TEMPERATURE - degrees C.	+3,000	+4,000	+5,000	+6,000	+7,000	+8,000	+9,000	+10,000	+11,000	+12,000	+13,000	+14,000	+15,000
+47													
+45	35												
+43	38	34											
+41	40	37	34										
+39	43	40	36	33									
+37	46	42	39	36	33								
+35	48	45	42	38	35	33							
+33	51	47	44	41	38	35	32						
+31	53	50	47	44	41	38	34	32					
+29	56	53	49	46	43	40	37	34	31				
+27	59	55	52	49	46	43	40	37	34	31			
+25	61	58	55	51	48	45	42	39	37	34	31		
+23	64	60	57	54	51	48	45	42	39	36	34	31	
+21	66	63	60	57	54	50	47	44	42	39	36	34	32
+19	69	66	62	59	56	53	50	47	44	42	39	36	34
+17	72	68	65	62	59	55	52	50	47	44	41	39	37
+15	74	71	68	64	61	58	55	52	49	47	44	42	39
+13	77	73	70	67	64	61	58	55	52	49	47	44	42
+11	79	76	73	69	66	63	60	57	54	52	49	47	44
+ 9	82	79	75	72	69	66	63	60	57	54	52	49	47
+ 7	85	81	78	75	72	68	65	62	60	57	54	52	50
+ 5		84	80	77	74	71	68	65	62	60	57	55	52
+ 3		85	83	80	77	73	70	68	65	62	59	57	55
+ 1			85	82	79	76	73	70	67	65	62	60	57
- 1				85	82	79	76	73	70	67	65	62	60
- 3					84	81	78	75	72	70	67	65	62
- 5					85	84	81	78	75	72	70	67	65
- 7						85	83	80	77	75	72	70	68
- 9							85	83	80	77	75	72	70
-11								85	82	80	78	75	73
-13									85	82	80	78	75
-15										85	83	80	78
-17											85	83	80
-19												85	83
-21													85

Take-off trim settings must not exceed 85 per cent trim

PRESSURE ALTITUDE - ft.

G7321

Fuel datum setting chart:
Mk.536-7P and 536-7R
CHART 2E

1. Use Chart 2D for ground runs at pressure altitude between + 4,000 and + 15,000 ft. for Mk.532-7N and 532-7P engines.

2. Use Chart 2E for ground runs at pressure altitude between + 3,000 and + 15,000 ft. for Mk.536-7P and 536-7R engines.

3. Use Charts 2B and 2C for ground runs at pressure altitude between + 3,000 and + 10,000 ft. for other engine Mks.

4. Do not carry out power checks at ambient conditions in excess of I.S.A. + 35 degrees C.

Power plant - Adjustment/test (cont.)

Use chart 2F for ground-runs at pressure altitude between +3,000 and +15,000 ft.

Do not carry out power checks at ambient conditions in excess of I.S.A. + 35 degrees C.

AMBIENT TEMPERATURE - degrees C.	+3,000	+4,000	+5,000	+6,000	+7,000	+8,000	+9,000	+10,000	+11,000	+12,000	+13,000	+14,000	+15,000
+ 9													
+ 7													
+ 5	4												
+ 3	9	2											
+ 1	15	7	1										
- 1	20	12	6										
- 3	25	17	11	4									
- 5	30	22	15	9	4								
- 7	35	27	20	14	8	2							
- 9	40	32	25	18	13	6	2						
-11	45	37	30	23	17	11	6	1					
-13	51	42	34	27	22	15	10	5	1				
-15	56	47	39	32	27	20	14	9	5				
-17	61	52	44	37	31	24	19	13	9	4			
-19	66	57	49	42	36	29	23	17	13	8	4		
-21	72	62	53	46	40	33	27	22	17	12	8	4	
-23	77	67	58	51	45	38	32	26	21	15	12	8	3
-25	82	72	63	56	49	42	36	30	25	19	15	11	7
-27	87	77	68	60	54	47	40	34	29	23	19	15	10
-29	92	82	73	65	58	51	45	38	33	27	23	18	14
-31	97	87	77	70	63	55	49	42	37	31	26	22	17
-33	103	92	88	74	67	60	53	47	41	35	30	25	21
-35	108	97	87	79	72	64	57	51	45	39	34	29	24
-37	113	102	92	84	76	69	62	55	48	43	38	33	28
-39	119	107	96	88	81	73	66	59	52	47	41	36	31
-41	124	112	101	93	85	78	70	63	56	51	45	40	35
-43	129	117	106	98	90	82	75	67	60	55	49	43	38
-45	134	122	111	102	95	86	79	72	64	59	53	47	42
-47	139	127	116	107	99	91	83	76	68	62	56	50	45
-49	144	132	120	111	104	95	88	80	72	66	60	54	49
-51	149	136	125	116	108	100	92	84	76	70	64	58	52

NO CORRECTION

PRESSURE ALTITUDE - ft.

G7319

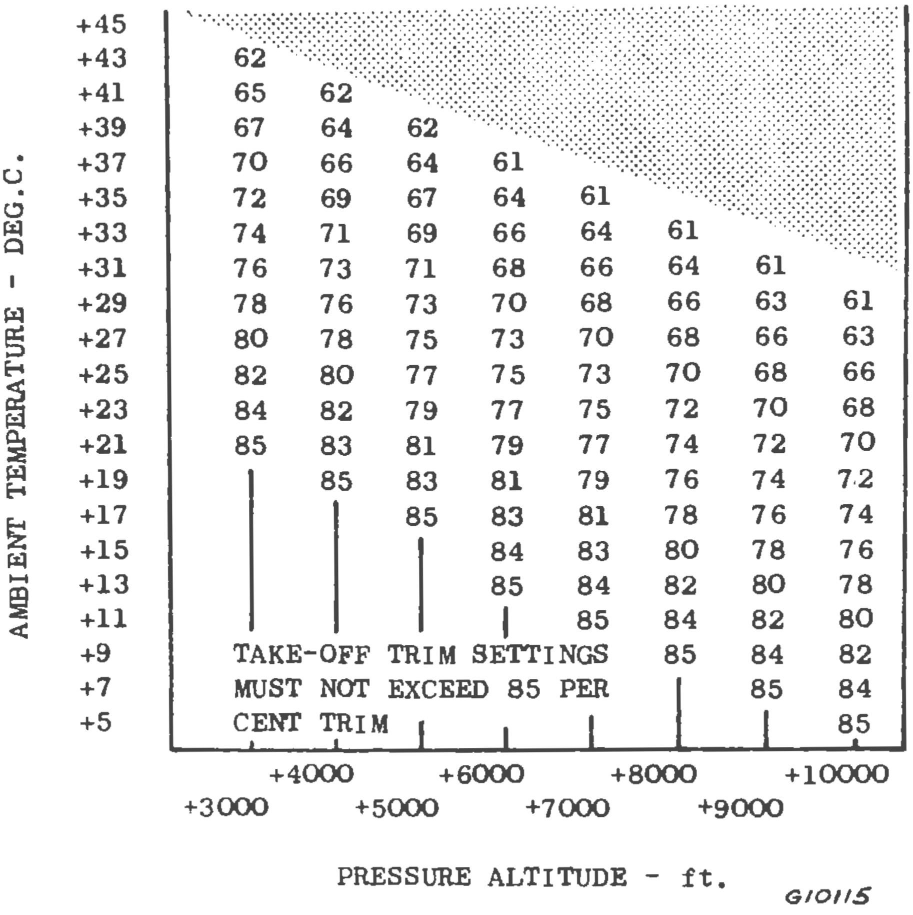
Turbine gas temperature correction chart
CHART 2F

Subtract above correction from the Data-plate maximum or minimum turbine gas temperature or Operating limitations maximum turbine gas temperature at Take-off r.p.m. as appropriate.

To obtain the Datum T.G.T. (Pre-removal run, RUN 1 in Sub-section 4D 'REMOVAL/ RE-INSTALLATION GROUND RUN - DRY'). ADD the T.G.T. correction to the observed value.

NOTE: This is the only occasion when the correction is ADDED to the T.G.T.

Power plant - Adjustment/test (cont.)



AMBIENT TEMPERATURE - DEG.C.	+3000	+4000	+5000	+6000	+7000	+8000	+9000	+10000
+45								
+43	62							
+41	65	62						
+39	67	64	62					
+37	70	66	64	61				
+35	72	69	67	64	61			
+33	74	71	69	66	64	61		
+31	76	73	71	68	66	64	61	
+29	78	76	73	70	68	66	63	61
+27	80	78	75	73	70	68	66	63
+25	82	80	77	75	73	70	68	66
+23	84	82	79	77	75	72	70	68
+21	85	83	81	79	77	74	72	70
+19		85	83	81	79	76	74	72
+17			85	83	81	78	76	74
+15				84	83	80	78	76
+13				85	84	82	80	78
+11					85	84	82	80
+9						85	84	82
+7							85	84
+5								85

TAKE-OFF TRIM SETTINGS MUST NOT EXCEED 85 PER CENT TRIM

PRESSURE ALTITUDE - ft.

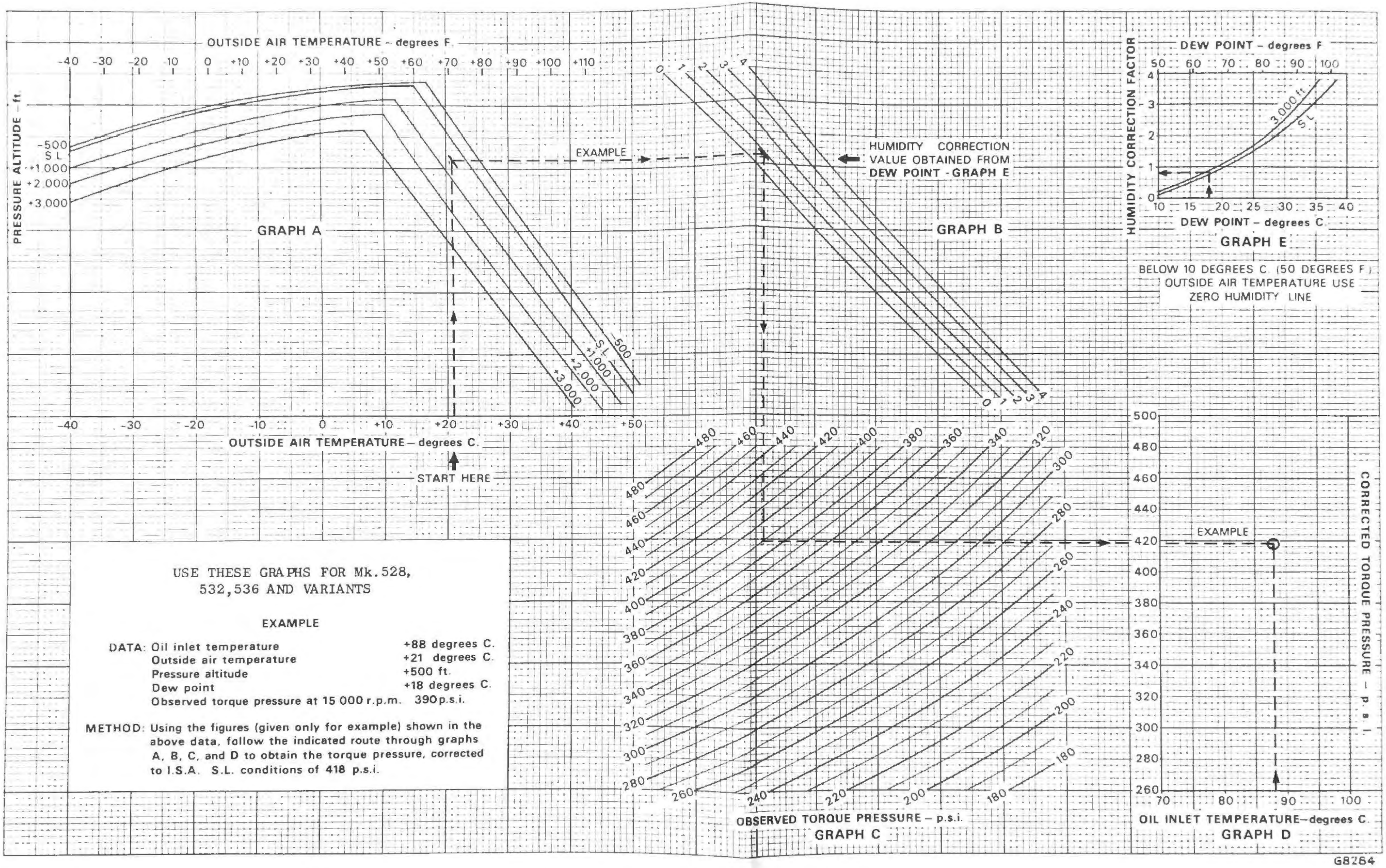
G10115

Fuel datum setting chart
Mk.551-7 and 551-7R
CHART 2G

1. Use Chart 2G for ground runs at pressure altitude between +3,000 and +10,000 ft. for Mk.551-7 and Mk.551-7R.

2. Do not carry out power checks at ambient conditions in excess of I.S.A. +35 degrees C.

Power plant - Adjustment/test (cont.)



USE THESE GRAPHS FOR Mk.528, 532,536 AND VARIANTS

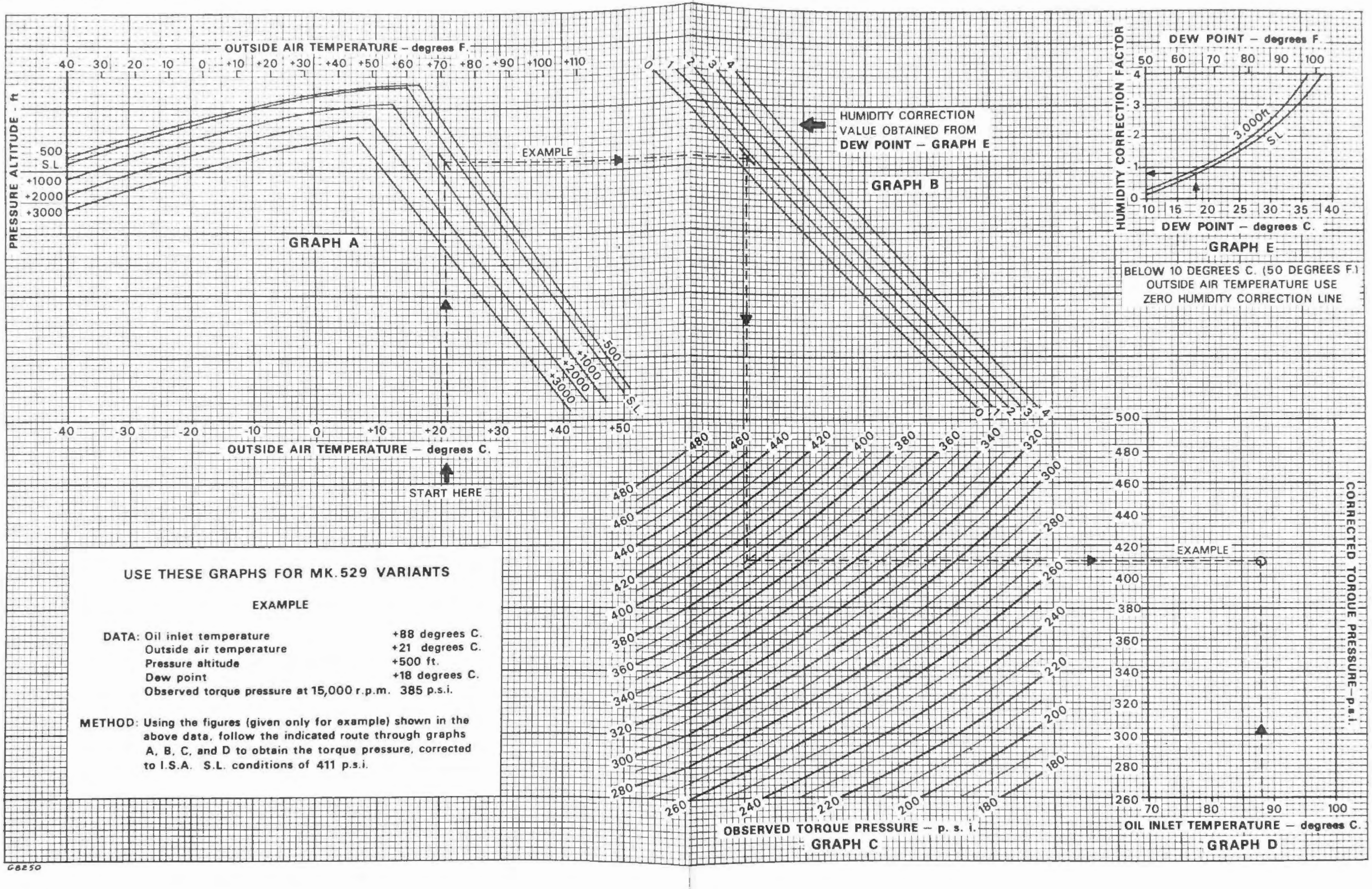
EXAMPLE

DATA:
Oil inlet temperature +88 degrees C.
Outside air temperature +21 degrees C.
Pressure altitude +500 ft.
Dew point +18 degrees C.
Observed torque pressure at 15 000 r.p.m. 390 p.s.i.

METHOD: Using the figures (given only for example) shown in the above data, follow the indicated route through graphs A, B, C, and D to obtain the torque pressure, corrected to I.S.A. S.L. conditions of 418 p.s.i.

Torque pressure correction graphs
for pressure altitudes of -500 to +3,000 ft.
Fig.522

Power plant - Adjustment/test (cont.)



USE THESE GRAPHS FOR MK.529 VARIANTS

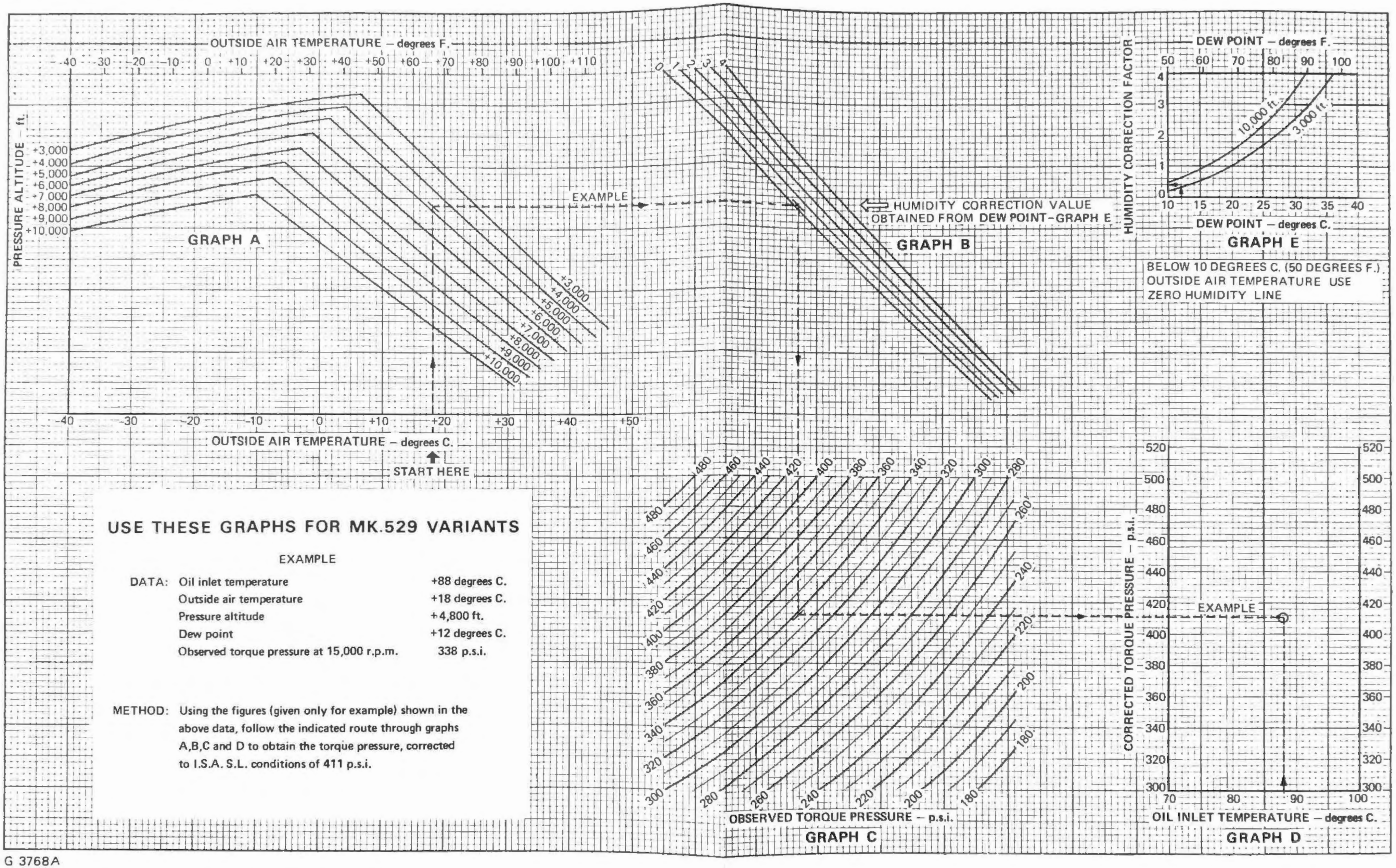
EXAMPLE

DATA:	Oil inlet temperature	+88 degrees C.
	Outside air temperature	+21 degrees C.
	Pressure altitude	+500 ft.
	Dew point	+18 degrees C.
	Observed torque pressure at 15,000 r.p.m.	385 p.s.i.

METHOD: Using the figures (given only for example) shown in the above data, follow the indicated route through graphs A, B, C, and D to obtain the torque pressure, corrected to I.S.A. S.L. conditions of 411 p.s.i.

Torque pressure correction graphs
for pressure altitudes of -500 to +3,000 ft.
Fig.523

Power plant - Adjustment/test (cont.)



USE THESE GRAPHS FOR MK.529 VARIANTS

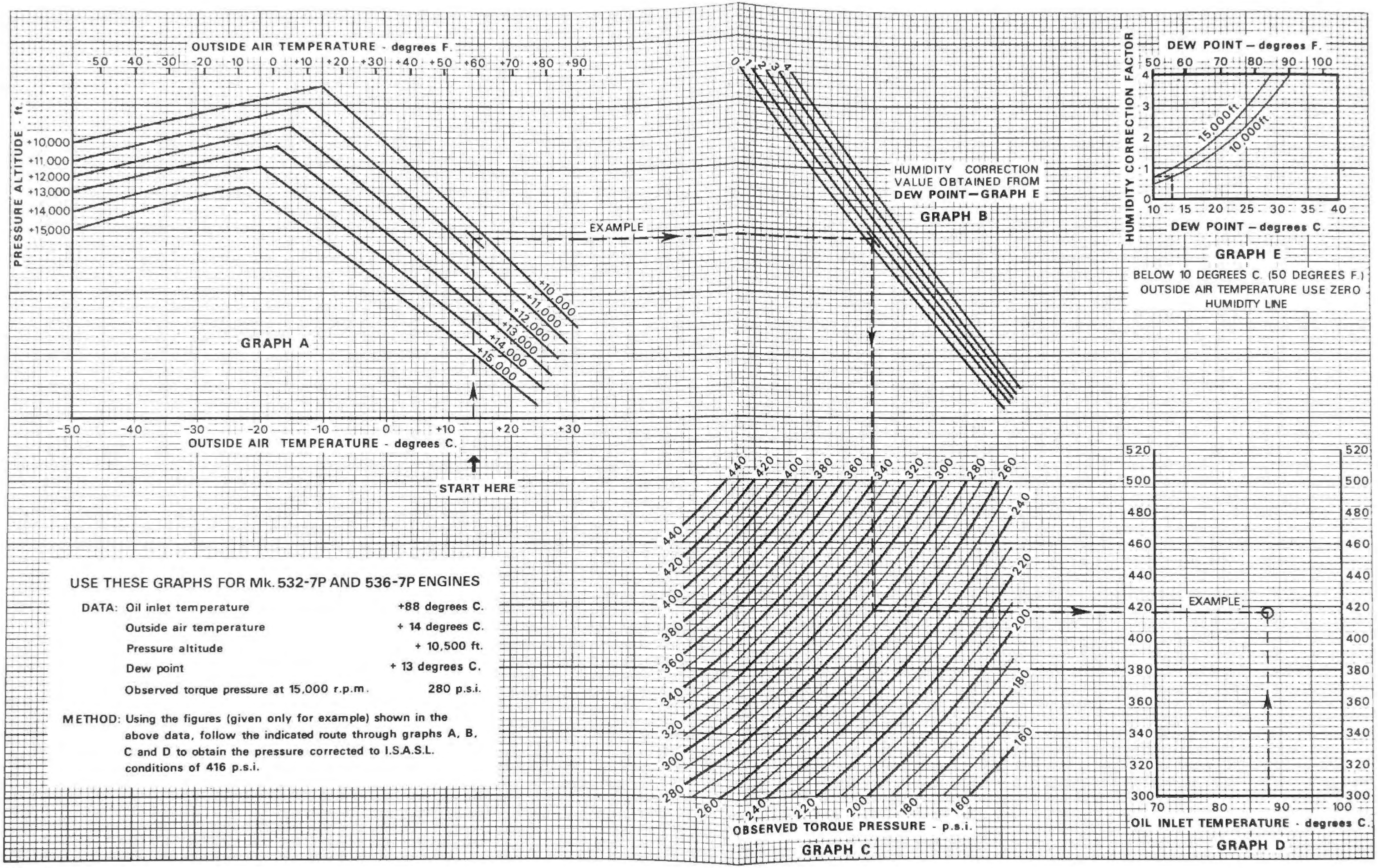
EXAMPLE

DATA:	Oil inlet temperature	+88 degrees C.
	Outside air temperature	+18 degrees C.
	Pressure altitude	+4,800 ft.
	Dew point	+12 degrees C.
	Observed torque pressure at 15,000 r.p.m.	338 p.s.i.

METHOD: Using the figures (given only for example) shown in the above data, follow the indicated route through graphs A,B,C and D to obtain the torque pressure, corrected to I.S.A. S.L. conditions of 411 p.s.i.

G 3768A

Torque pressure correction graphs
for pressure altitudes of +3,000 to +10,000 ft.
Fig.525



USE THESE GRAPHS FOR Mk. 532-7P AND 536-7P ENGINES

DATA:		
	Oil inlet temperature	+88 degrees C.
	Outside air temperature	+ 14 degrees C.
	Pressure altitude	+ 10,500 ft.
	Dew point	+ 13 degrees C.
	Observed torque pressure at 15,000 r.p.m.	280 p.s.i.

METHOD: Using the figures (given only for example) shown in the above data, follow the indicated route through graphs A, B, C and D to obtain the pressure corrected to I.S.A.S.L. conditions of 416 p.s.i.

G 7289A

Torque pressure correction graphs for Mk.532-7P and 536-7P engines at pressure altitudes of +10,000 to +15,000 ft.

Fig.526

DESCRIPTION

FUEL DRAIN SYSTEM

Unburnt fuel accumulating in the combustion chambers — as in the case of a failure to start — is drained directly by a series of drain tubes interconnecting certain combustion chambers and indirectly by draining the lowest points of the second-stage compressor, of No. 5 compressor outlet elbow, and of the nozzle box.

A common collecting point for this fuel drain accumulation is provided by a drain valve mounted beneath the No. 5 expansion chamber. To this collecting point is brought also the drain from the intermediate casing and the pipe carrying the combined drain from units forward of the engine bulkhead, i.e. the water methanol unit, fuel pump and flow control unit.

The turbine heat shield is provided with a separate drain which has a connection for an additional aircraft pipe to follow the run of the main drain pipe rearward to the aircraft collecting box.

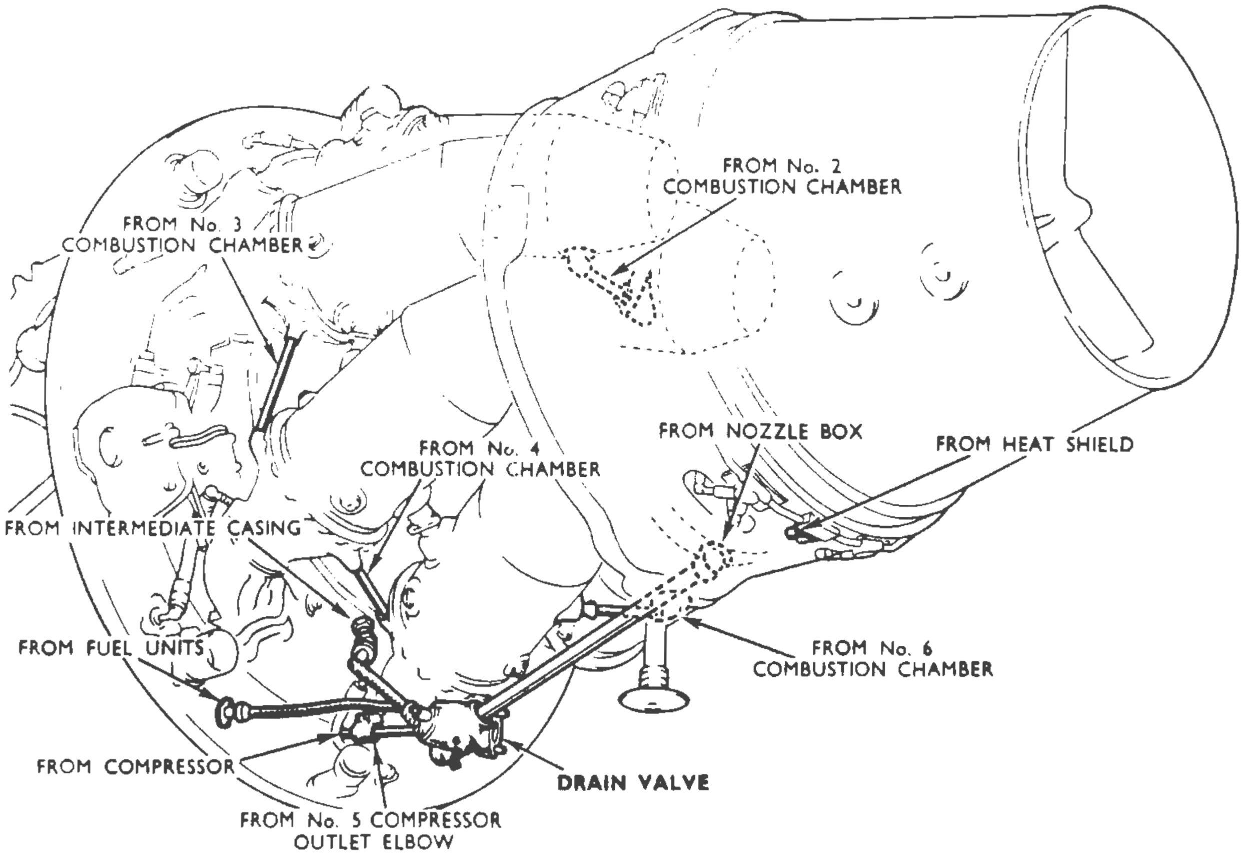

FROM No. 2 COMBUSTION CHAMBER
FROM No. 3 COMBUSTION CHAMBER
FROM No. 4 COMBUSTION CHAMBER
FROM NOZZLE BOX
FROM HEAT SHIELD
FROM INTERMEDIATE CASING
FROM FUEL UNITS
FROM No. 6 COMBUSTION CHAMBER
FROM COMPRESSOR
DRAIN VALVE
FROM No. 5 COMPRESSOR OUTLET ELBOW
1891

Fig. 1 Fuel drain system

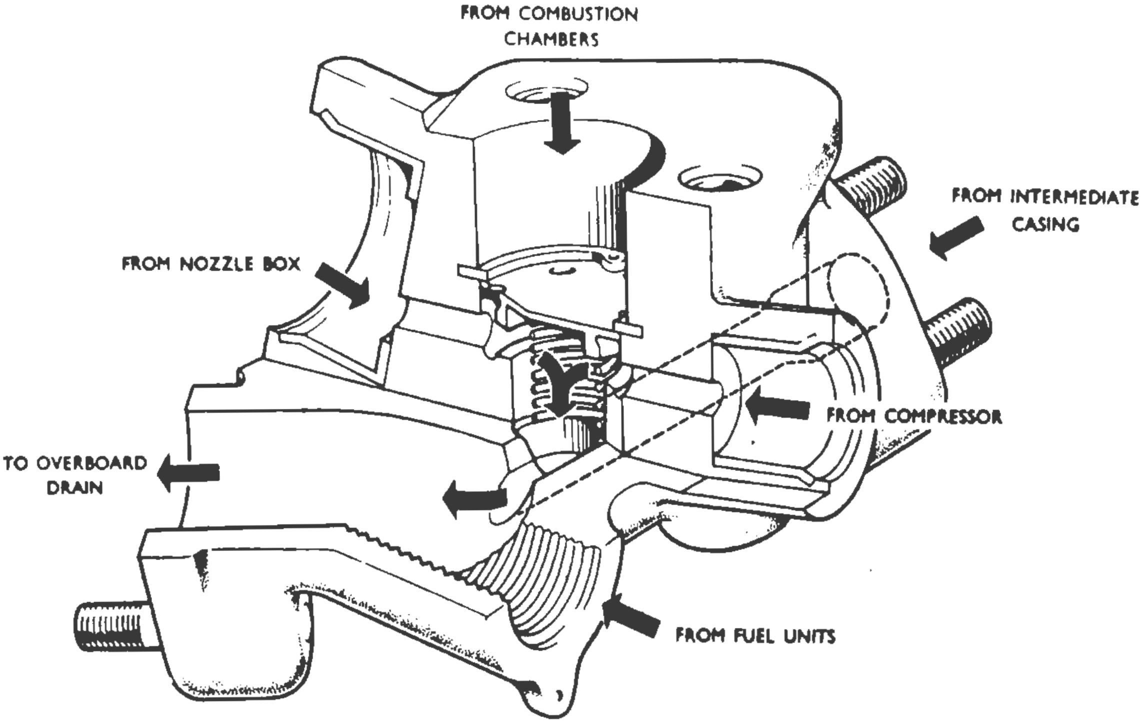


Fig. 2 Fuel drain valve

Whilst the engine is stationary, the drain valve permits fuel to be discharged overboard from the combustion chambers, the compressor and nozzle box. As soon as the engine has started up, the internal pressure will rise and close the lightly spring-loaded valve to seal off these drains from atmosphere.

The combined drain from the units forward of the bulkhead and the drain from the intermediate casing are discharged into the outlet side of the valve and are therefore unaffected by its operation.

MAINTENANCE PRACTICES

FUEL DRAIN SYSTEM

FUEL DRAINAGE LIMITS

With the H.P. cock shut and the tank pumps on, the fuel drainage from the engine main drain should not exceed 5 c.c. per min. If it does, disconnect the drain at the F.C.U. and measure the leakage rate at each fuel unit. If the leakage rate from either unit exceeds 5 c.c. per min., reject the unit.

Before rejecting a suspected F.C.U., ensure the engine control static settings are correct, i.e. H.P. cock lever is between SHUT engravings on unit.

COMBUSTION CHAMBER DRAIN VALVE REMOVAL

Disconnect the intermediate casing oil drain pipe from the valve by removing the two securing nuts and drawing the flange away from the unit.

Disconnect the combined fuel unit drain pipe.

Disconnect the overboard drain pipe from the valve by removing the two securing nuts and drawing the flange away from the unit.

Remove the two setscrews to release the 2-way drain connection from No. 5 compressor outlet elbow.

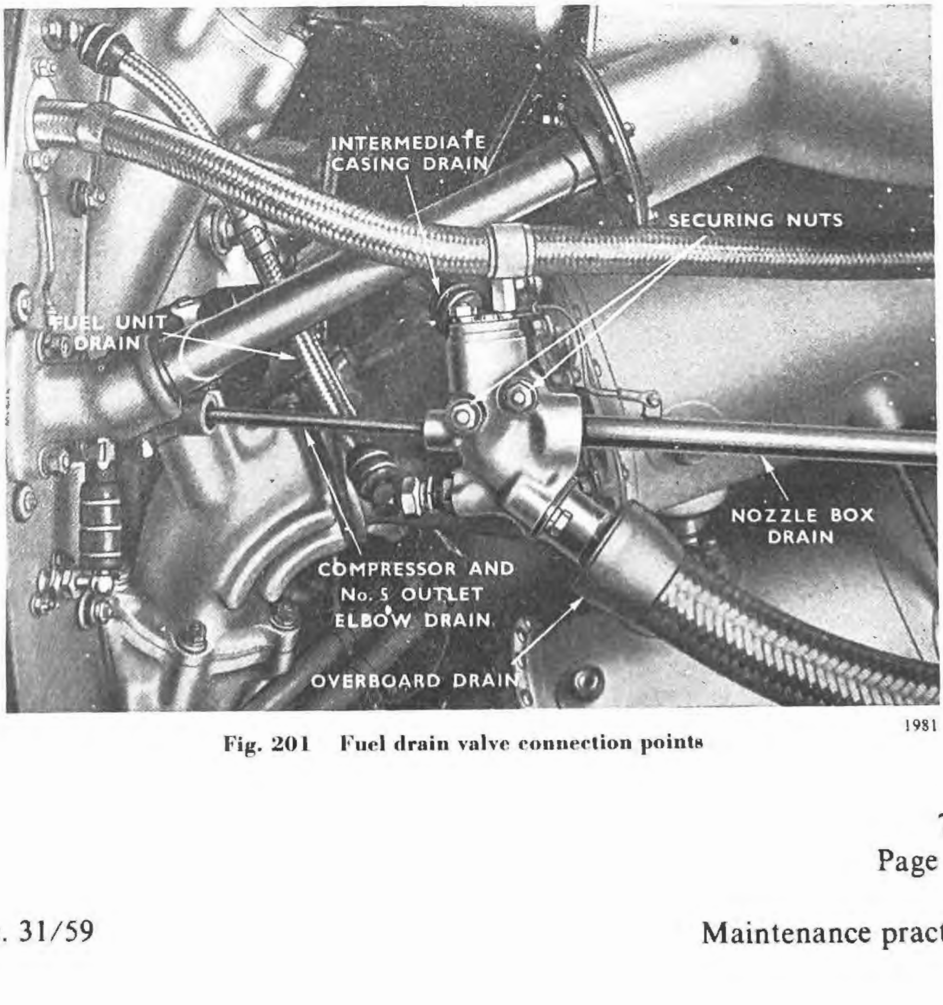

INTERMEDIATE CASING DRAIN
SECURING NUTS
FUEL UNIT DRAIN
NOZZLE BOX DRAIN
COMPRESSOR AND No. 5 OUTLET ELBOW DRAIN
OVERBOARD DRAIN
1981

Fig. 201 Fuel drain valve connection points

Remove the two drain valve securing nuts, draw the valve off the studs, releasing the drain tubes from the nozzle box and the 2-way connection draining the compressor and No. 5 outlet elbow.

REPLACEMENT

Pre-Mod. 546, ensure that two piston-ring-type sealing rings are fitted to each end of the drain tubes; these must not be fitted when any part of Mod. 583 (drain tubes in aluminium and casing, etc., liners deleted) is embodied.

With Mod. 546 embodied, fit rubber sealing rings, using silicone compound MS.4.

Insert the short compressor drain tube into its bore in the 2-way drain connection, inserting the longer drain tube into the opposite end.

Insert the free end of the longer tube into its bore in the drain valve body, and the appropriate end of the nozzle box drain tube into its connection in the nozzle box.

Inserting the free end of the short drain tube into the compressor drain connection and the free end of the nozzle box drain tube into its bore in the drain valve body, fit the complete assembly into position on the two studs on No. 5 expansion chamber.

Secure the valve body with nuts, plain washers and tabwashers.

After applying a thin film of jointing compound (89-12) to the mating faces, secure the 2-way drain connection to No. 5 outlet elbow with setscrews and plain and Grover washers.

Using a new joint packing, locate the free end of the braided intermediate casing drain pipe on the left-hand facing of the drain valve body, and secure the pipe with nuts and Grover washers.

Secure the fuel unit drain pipe to the screwed connection on the drain valve body.

Using a new joint packing, position the overboard drain pipe end on the rearward facing connection of the valve body, and secure with nuts and Grover washers.

Check the drain tubes for freedom of movement (pre-Mod. 546 only).

DESCRIPTION

FIRE EXTINGUISHING PIPES

The forward part of the engine carrying the fuel system components is isolated from the hot zone by a fireproof bulkhead. To prevent inflammable vapour passing into the hot zone, the bulkhead is arranged to seal against the cowling and all pipes and cables passing through the bulkhead are sealed or isolated by heat shields.

The fire warning system, described in the aircraft manual, includes a detector in an extension of the wheelcase breather outlet duct to warn of a fire in the engine cooling air system.

Provision for extinguishing a fire consists of two fire extinguishing rings arranged to spray methyl bromide from containers mounted on the aircraft. The ring round the intake cowling is arranged to spray rearwards to blanket the fuel system, and the ring at the front of the hot zone to spray rearwards to blanket the combustion chambers and nozzle box.

The rings, made of stainless steel tubing, are secured to the engine by metal clips and are fed through a connection on the port side of the engine bulkhead.

MAINTENANCE PRACTICES

FIRE EXTINGUISHING PIPES

SERVICING

Carry out a visual examination of the fire extinguishing pipes for chafing and for security of clips and wire locking.

Check the discharge holes for obstruction as follows.

Uncouple a connection between the extinguishant container on the aircraft and the engine spray pipes.

Apply an air pressure of 50 to 70 lb. per sq. in. and check that all air holes vent freely. If any holes are found blocked, clean carefully with a No. 60 drill (0.040 in.) or a straight piece of 20 S.W.G. steel wire (0.036 in.).

Recouple the connection to the container.

Information on the maintenance and rectification of the continuous element detector system mounted on the engine is covered in the aircraft manufacturer's instructions.

It is important that the cowling drains are maintained clean and free from obstruction (see aircraft manufacturer's instructions).

Methyl bromide and chlorobromomethane fire extinguishing fluids are highly corrosive, particularly in the presence of water; if for any reason they come into contact with the engine, immediate action must be taken as described below.

ACTION FOLLOWING DISCHARGE OF FIRE EXTINGUISHERS

The following action may be required where an aircraft has been subject to the discharge of aircraft or ground fire extinguishers, and assumes the engine is otherwise serviceable.

Aircraft fire extinguishing system

Many aircraft fire extinguishing systems use methyl bromide and it should be noted that its vapour is highly toxic and heavier than air; some aircraft systems use chlorobromomethane, and although less toxic than methyl bromide, precaution must be taken with both systems for the protection of ground personnel.

The maximum possible ventilation should be provided; if the discharge has taken place inside the hangar, the aircraft should if possible be moved out into the open air.

Protective rubber gloves should be worn whenever there is a possibility of contact with these liquids. Any local regulations should also be observed.

Liquid and vapour methyl bromide and liquid chlorobromomethane are corrosive to aluminium, magnesium, mild steel and to cadmium and chromium plate, particularly in the presence of water, but not to surfaces protected by paint, cellulose and phenolic resin. Corrosion is unlikely to result from a few hours' exposure to the vapour, but it is essential to uncowl the engine as soon as possible after the discharge.

Exercise care in opening the power plant cowlings, especially the lower panels where liquid may lodge.

Where methyl bromide has been used at air temperatures above plus 4 deg. C., its boiling point, open the cowlings for approximately 30 minutes to allow any liquid to vaporize and disperse; at air temperatures below plus 4 deg. C., open the cowlings and wipe away excess liquid.

Where chlorobromomethane has been used, the residual liquid must be removed.

Investigate the cause of the discharge, and rectify where necessary.

Blow through the feed and spray pipes to dispel residual liquid, then check the spray holes as described above.

Replace the extinguishant container(s) in accordance with the instructions in the aircraft maintenance manual.

Close the cowlings, start and run the engine to vaporize any remaining liquid in inaccessible parts of the engine.

The running time required will vary: a few minutes at idling when ambient temperatures are high may be sufficient for methyl bromide, but for chlorobromomethane, or for methyl bromide at ambient temperatures below plus 4 deg.C., 10 minutes at 13,500 r.p.m. may be required.

Ground fire extinguishing equipment

The extinguishants likely to be used are listed below, followed by the appropriate action to be taken in each case, in addition to investigating and rectifying, as required, the cause of the fire.

Where a fire extinguishant of the liquid type has been discharged into the intake, remove the plug in the bottom of the first-stage compressor casing and drain off any fluid; this should be done as soon as possible even if the engine is to be returned to an overhaul base. If possible, carry out a motoring cycle, followed by a ground run for at least 2 minutes at cruising conditions to ensure that all traces of the liquid extinguishant are removed.

Where the compressor casing is drained and a ground run is carried out within 24 hours, no further action is required. If, however, the engine has been allowed to stand for more than 24 hours with fire extinguisher fluid remaining in the compressor casing, the engine must be removed and returned to an overhaul base for a strip inspection.

Carbon dioxide

As this is a gas leaving no trace and cannot cause any blockage of the fuel drains, etc., no further action is required.

Foam

Where foam has been used externally, the possibility of corrosion of magnesium parts can be minimized by washing down with water before the foam has solidified. If this has not been done, evidence of the use of foam will remain as a cream-coloured sludge, or crust on hot surfaces. The sludge can be removed by wiping down with paraffin; the crust may requite more drastic means for its removal. The engine spray pipes should be blown through and checked as described earlier.

Foam-type extinguishers discharged into the intake or up the jet pipe into the exhaust unit to penetrate the turbine are liable to cause clogging of the combustion chamber drain system and the engine must be returned for strip inspection.

Before returning the engine, minimize the possibility of corrosion from the discharge into the intake by washing through with water; allow this to drain through the first-stage compressor drain, then insert desiccant to dry out the engine.

Dry powder

Where a dry powder-type extinguisher has been used, as evidenced by the white residue, penetration of powder internally to the hot components could result in the formation of a glaceous deposit which may upset the balance of the turbine assembly. If released into the air intake, the powder combines with the synthetic oil used in the engine to form a sludge.

If there is any possibility of the powder having penetrated internally, therefore, the engine must be returned for strip inspection.

Glycol/water

If fire extinguishers of this type have been discharged into the intake, it is important that fluid does not remain in the compressor casing where it may cause corrosion (see above). Glycol/water should not normally be used on electrical fires; where it has been used, examine the electrical harness connections for moisture, and dry out where necessary.

Carbon tetrachloride

Although non-corrosive to the metals on the engine, carbon tetrachloride should not be allowed to remain in contact with rubber and plastic materials.

Action similar to that for methyl bromide should be taken to disperse residual liquid.

ELECTRICAL SERVICES - DESCRIPTION

1. General

With the exception of the power unit ice protection system, the thermocouple harness and the inductor-type oil pressure transmitter, all electrical services on the engine are energized by a nominal 24 V.d.c. supply drawn from the aircraft system. To start the engine for ground running, an external 28 V. supply of high capacity is required, as described in 89-11.

2. Thermocouple harness

Mounted on the nozzle box heat shield is the thermocouple harness assembly which comprises conduit-enclosed cables linking the thermocouples, through a series of intermediate junction boxes, to a main junction box on the underside of the engine. From the main junction box, the electro-motive force (e.m.f.) generated by the thermocouples is conveyed to the turbine gas temperature (T.G.T.) indicator in the aircraft crew compartment by a separate electrical harness which is connected to the aircraft main harness system at the bulkhead. The thermocouple harness assembly and the T.G.T. indicator are covered in 77-2-1.

3. Power unit ice protection system and oil pressure transmitter

The power unit ice protection system and the inductor-type oil pressure transmitter are energized by an alternating current (a.c.) supply from the aircraft electrical system. The cables which serve the propeller and spinner ice protection system pass through a Tufnol block on the right-hand side of the engine air intake casing, and are ducted through the spinner extension to a brush assembly for which a mounting platform is provided on the forward face of the reduction gear casing. The pulse generator cables also pass through the same duct. On the left-hand side of the air intake casing a similar arrangement carries the cables to the propeller blade angle switches. The power unit ice protection system and the oil pressure transmitter are covered in 72-1 and 77-5-1, respectively.

4. H.T. ignition leads

The high tension (H.T.) electrical supply to the igniter plugs is carried by cables enclosed in separate, braided-metal, flexible conduits from two high-energy ignition units (80-3) mounted in the airframe.

5. Fire warning system

A fire warning system which consists of a heat-sensitive continuous element looped around the power plant, is connected to the aircraft electrical system through a control box mounted in the airframe.

6. Low tension (l.t.) electrical harness

With the exception of the power unit ice protection system and the inductor-type oil pressure transmitter, all electrically-operated units on the engine are energized by a 24 V.d.c. supply carried by a flexible harness assembly which incorporates sockets for connecting to the engine units, and screwed, pin-type plugs for connection at the aircraft bulkhead.

The harness assembly, which is led through the 'hot' zone of the engine, comprises four major sub-assemblies:

A. The left-hand harness assembly (Fig.1), which consists of a rigid, branch conduit (nickel chromium steel) terminating, at its forward extremities, in screwed adapters to which are connected flexible conduit branches and, at its rear extremity, in a flange to which is bolted a common housing for braided-metal flexible conduits carrying the cables to the aircraft bulkhead. Those flexible conduits carrying the cables to the engine units are of oil-resisting rubber hose covered with a Vulcaprene film. On engines which feature Mod.717, the left-hand harness is in two parts to facilitate assembly.

B. The right-hand (upper) harness assembly (Fig.2), which has an arrangement similar to that of the left-hand harness. The electrical supply to the pulse generator, which is served by this harness, is carried by a screened cable to obviate interference and ensure correct functioning of the unit.

C. The right-hand (lower) harness assembly (Fig.3), which consists of a rigid conduit (nickel chromium steel) terminating, at each extremity, in a flange to which is bolted a common housing for flexible conduit branches. Those branches carrying the cables to the aircraft bulkhead are of braided-metal, and those to the engine units are of oil-resisting rubber hose covered with a Vulcaprene film.

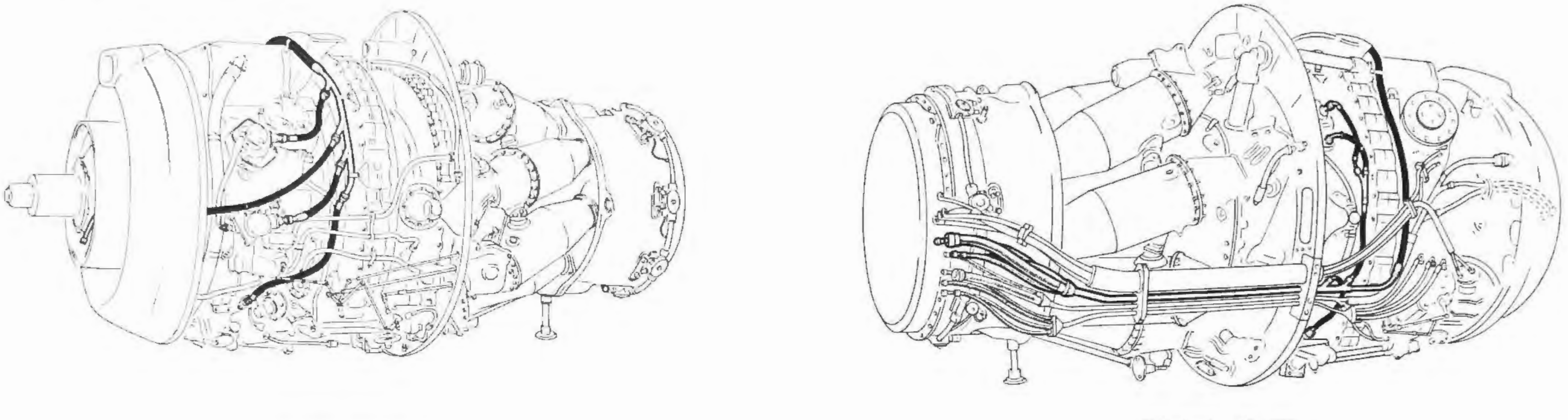
D. Starter motor and feathering pump leads (Fig.4), which consist of cables terminating in lugs and enclosed by flexible, oil-resisting, rubber hose conveyed through the engine hot zone by a nickel chromium rigid conduit. The rubber hose is covered with a Vulcaprene film.

The l.t. harness assembly serves the following engine units and systems:

(1) On left-hand side of engine.

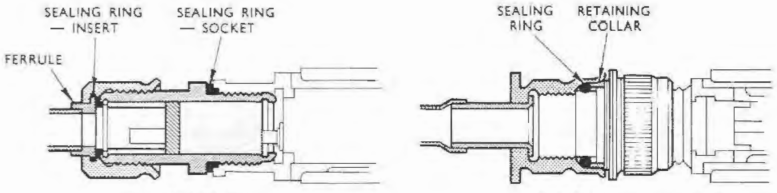
- (a) Low torque switch for auto-feathering (mounted on water/methanol unit)
- (b) Oil inlet temperature thermometer
- (c) Propeller blade angle switches
- (d) Torque meter pressure transmitter

Electrical services - Description (cont.)



Left-hand side view

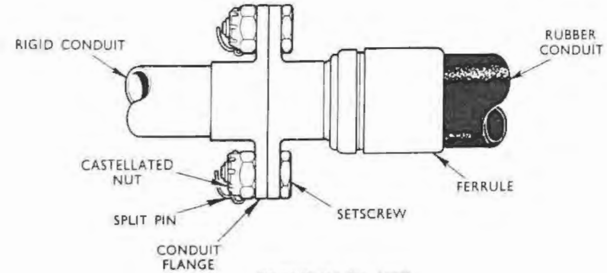
Right-hand side view



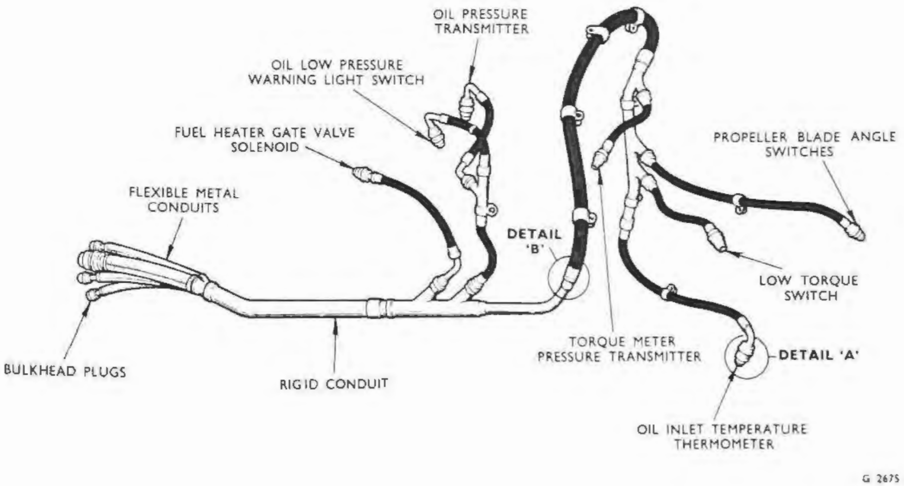
Pre-Mod.742 (Plessey socket)

Mod.742 (Cannon connector)

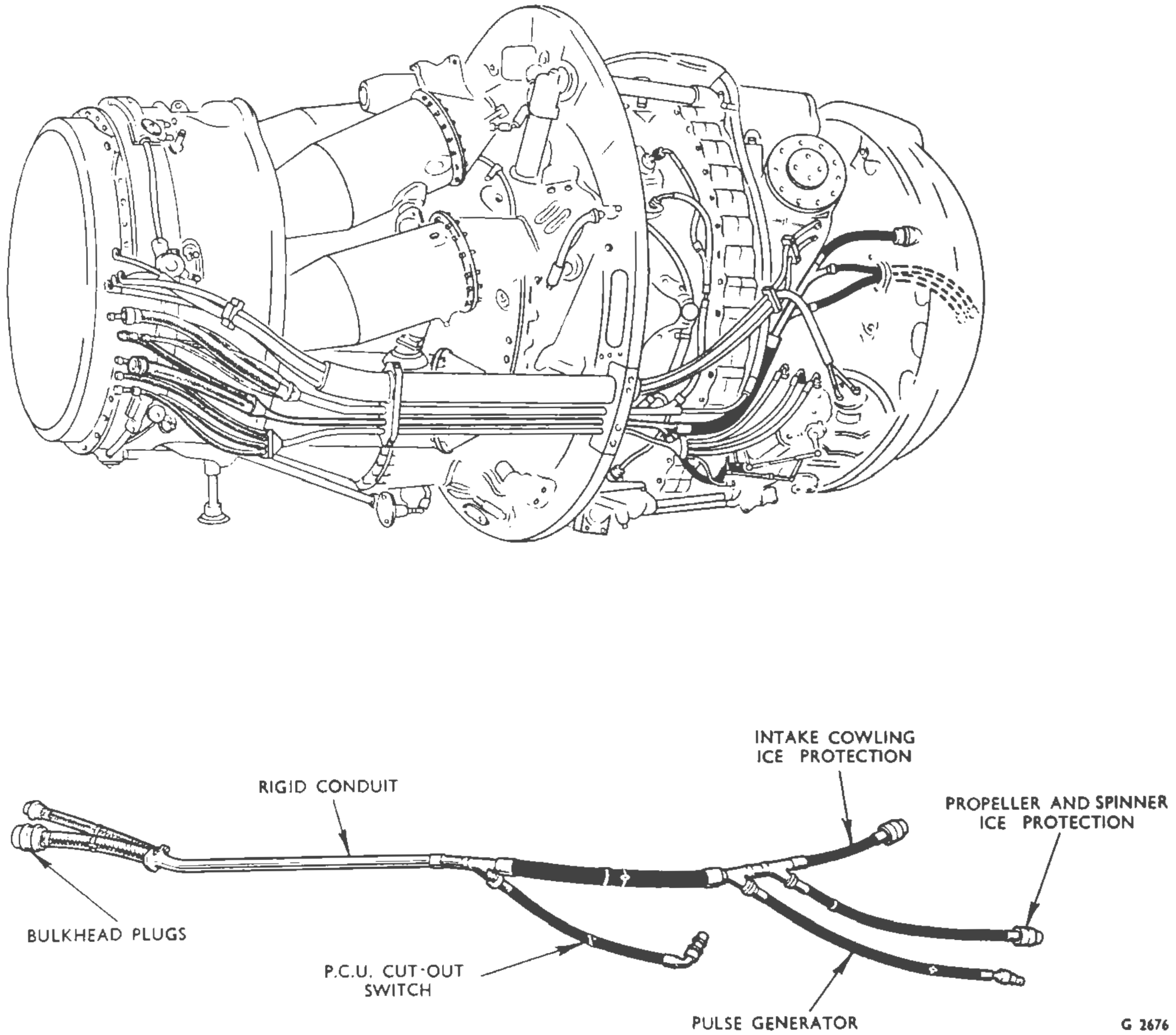
DETAIL 'A' (SECTIONAL VIEWS)



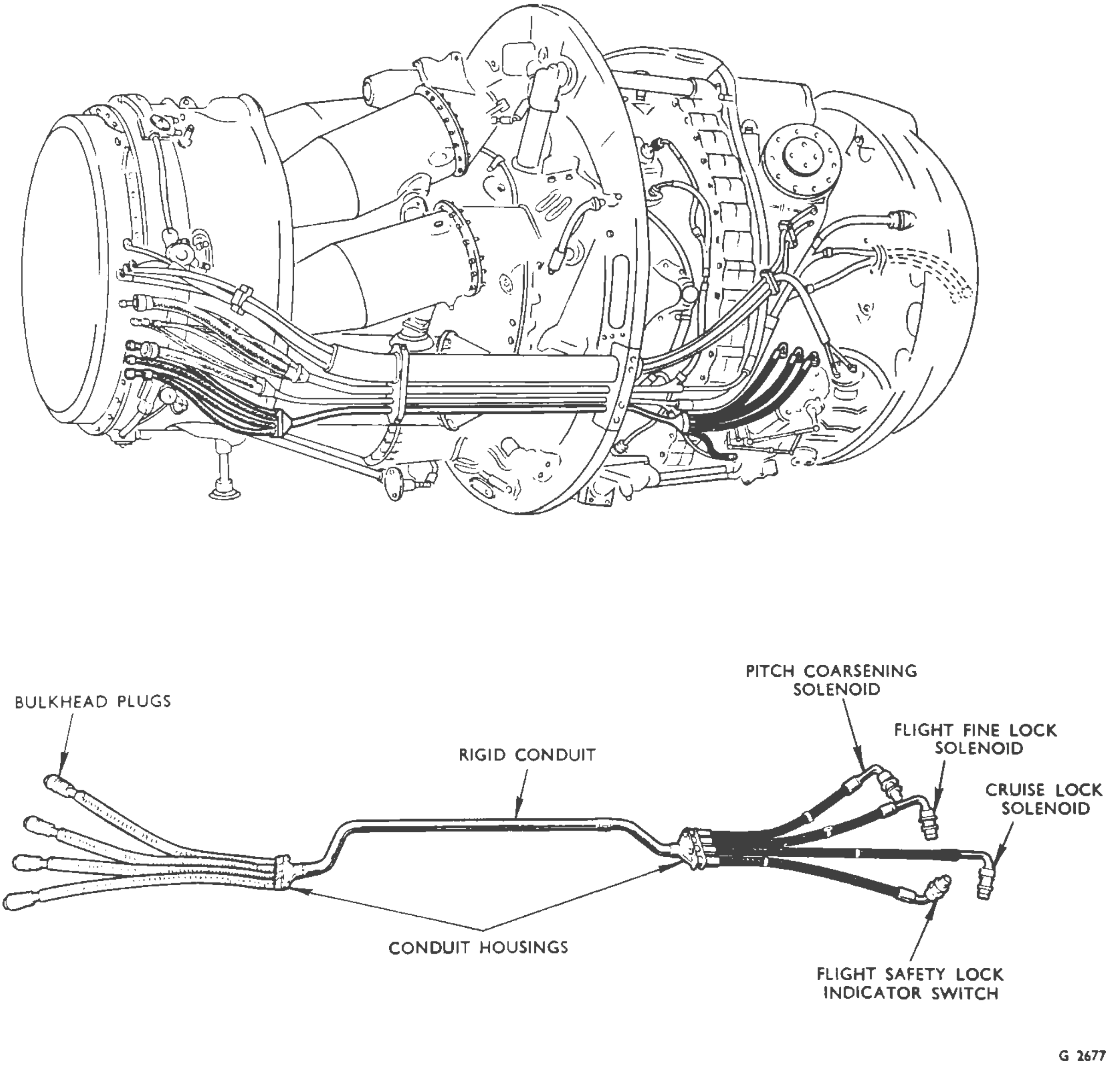
DETAIL 'B' (Mod.717)


OIL PRESSURE TRANSMITTER
OIL LOW PRESSURE WARNING LIGHT SWITCH
FUEL HEATER GATE VALVE SOLENOID
FLEXIBLE METAL CONDUITS
PROPELLER BLADE ANGLE SWITCHES
DETAIL 'B'
LOW TORQUE SWITCH
BULKHEAD PLUGS
RIGID CONDUIT
TORQUE METER PRESSURE TRANSMITTER
DETAIL 'A'
OIL INLET TEMPERATURE THERMOMETER
G 2675

Left-hand harness assembly
Fig.1

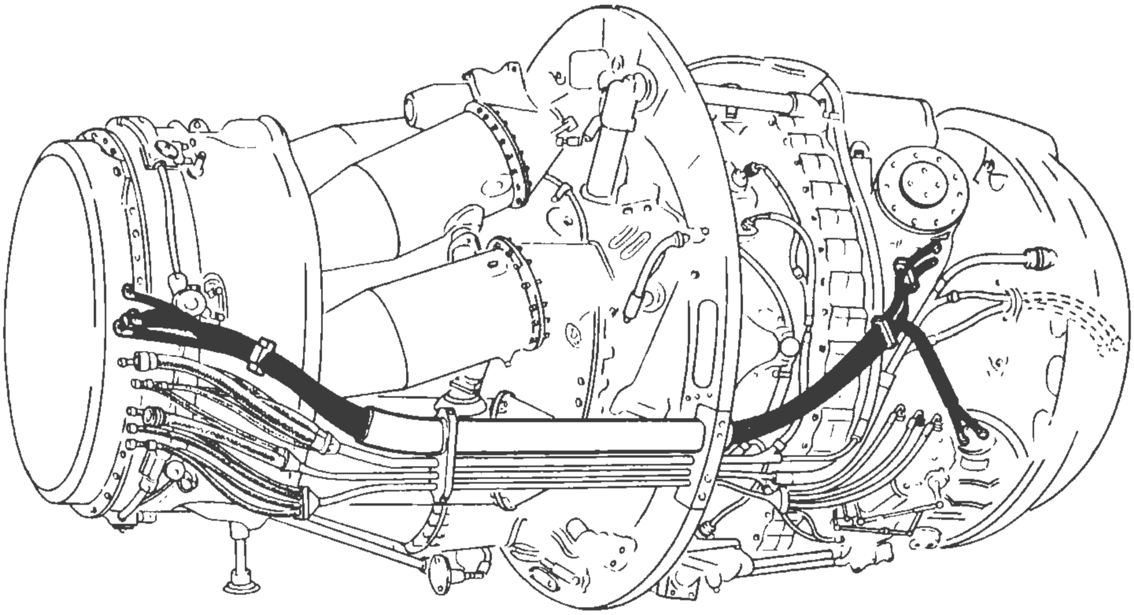


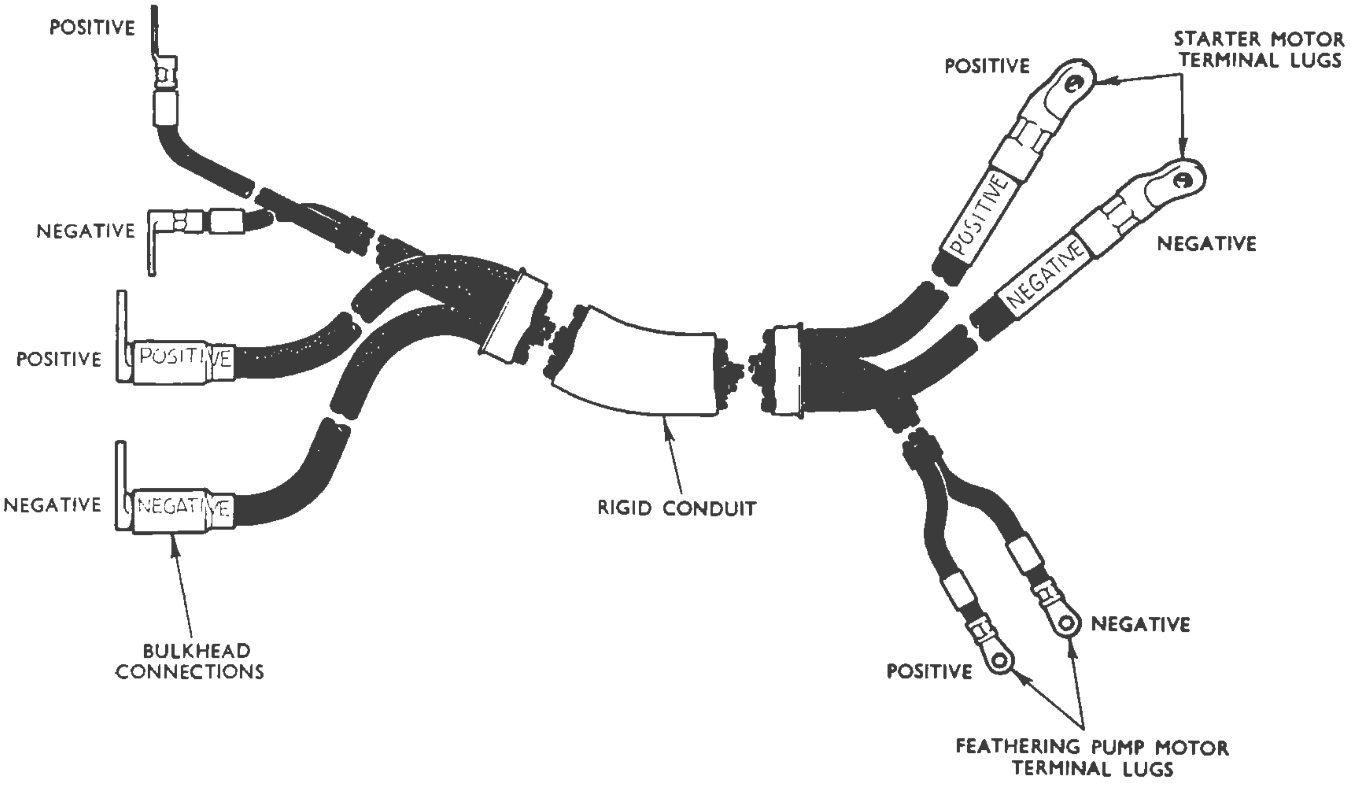
Right-hand (upper) harness assembly
Fig.2


BULKHEAD PLUGS
RIGID CONDUIT
PITCH COARSENING SOLENOID
FLIGHT FINE LOCK SOLENOID
CRUISE LOCK SOLENOID
CONDUIT HOUSINGS
FLIGHT SAFETY LOCK INDICATOR SWITCH
G 2677

Right-hand (lower) harness assembly
Fig.3

Electrical services - Description (cont.)





Starter motor and feathering pump leads
Fig.4

(2) On right-hand side of engine.

(a) Engine intake cowling ice protection system

(b) Propeller and spinner ice protection system

(c) Pulse generator

(d) P.C.U. cut-out switch (harness elbow painted red)

(e) Flight safety lock indicator switch (harness elbow painted yellow)

(f) Cruise lock solenoid

(g) Flight fine lock solenoid

(h) Pitch coarsening solenoid

(j) Fuel heater gate valve

(k) Oil pressure transmitter

(l) Oil low pressure warning light switch

(m) Starter motor

(n) Feathering pump

To obviate fire risk and interference with radio equipment due to electrical discharges, certain components on the engine are connected by bonding leads which form an electrically-continuous system with a low and unvarying resistance.

LOW TENSION HARNESS - MAINTENANCE PRACTICES

1. Removal/Installation

A. Remove the low tension (l.t.) harness assembly (fig.201)

(1) Disconnect the l.t. harness plugs from the aircraft bulkhead.

(2) Unscrew the socket ringnuts, then unscrew the socket shells to disconnect the harness from the following engine units; ensure that the harness cables do not twist while the socket shells are being unscrewed.

(a) Left-hand harness:

(i) Oil inlet temperature thermometer

NOTE: On engines which feature Mod.742, the socket connection to this unit is replaced by a plug connection.

(ii) Low torque switch

(iii) Propeller blade angle switches

(iv) Torque meter pressure transmitter

(v) Oil pressure transmitter

(vi) Oil low pressure warning light switch

(vii) Fuel heater gate valve solenoid

(b) Right-hand (upper) harness:

(i) Propeller and spinner ice protection system

(ii) Engine intake cowling ice protection system

(iii) Pulse generator

(iv) P.C.U. cut-out switch

(c) Right-hand (lower) harness:

(i) Cruise lock solenoid

(ii) Flight fine lock solenoid

(iii) Pitch coarsening solenoid

(iv) Flight safety lock indicator switch

(3) Disconnect the starter motor and feathering pump leads lug terminals from the aircraft bulkhead and from the units concerned.

(4) Remove the setscrews, spring washers and plain washers which secure the harness support clips to their mounting brackets on the engine.

(5) Remove the engine fireproof bulkhead sealing ring from its channel location.

(6) Remove the setscrews, spring washers and plain washers which secure the bulkhead bracket outer section; remove the outer section to expose the conduits.

(7) Remove the nuts, spring washers, plain washers and 'D' head bolts which secure the outer section of the l.t. harness strut bracket; remove the outer section.

(8) Remove the harness assembly from the engine.

B. Install the low tension (l.t.) harness assembly

(1) Ensure that the rubber half-bushes are correctly positioned in the bulkhead bracket and strut bracket inner section, respectively.

(2) Position the harness assembly on the engine and, with the exception of the starter leads conduit, engage the rigid conduit locating pegs with the appropriate holes in the bulkhead bracket inner section. Ensure that the rubber half-bushes are correctly positioned in the bracket outer section, then fit the section to the bulkhead; secure with the appropriate plain washers, spring washers and setscrews.

(3) Ensure that the rubber half-bushes are correctly positioned in the strut bracket outer section, then fit the section to secure the conduits; secure with the appropriate 'D' head bolts, plain washers, spring washers and nuts.

(4) Fit the engine fireproof bulkhead sealing ring to its channel location.

(5) Connect the harness plugs to the aircraft bulkhead.

(6) In the following harness order, and with the socket ringnuts fully unscrewed, screw the socket shells into the appropriate units on the engine:

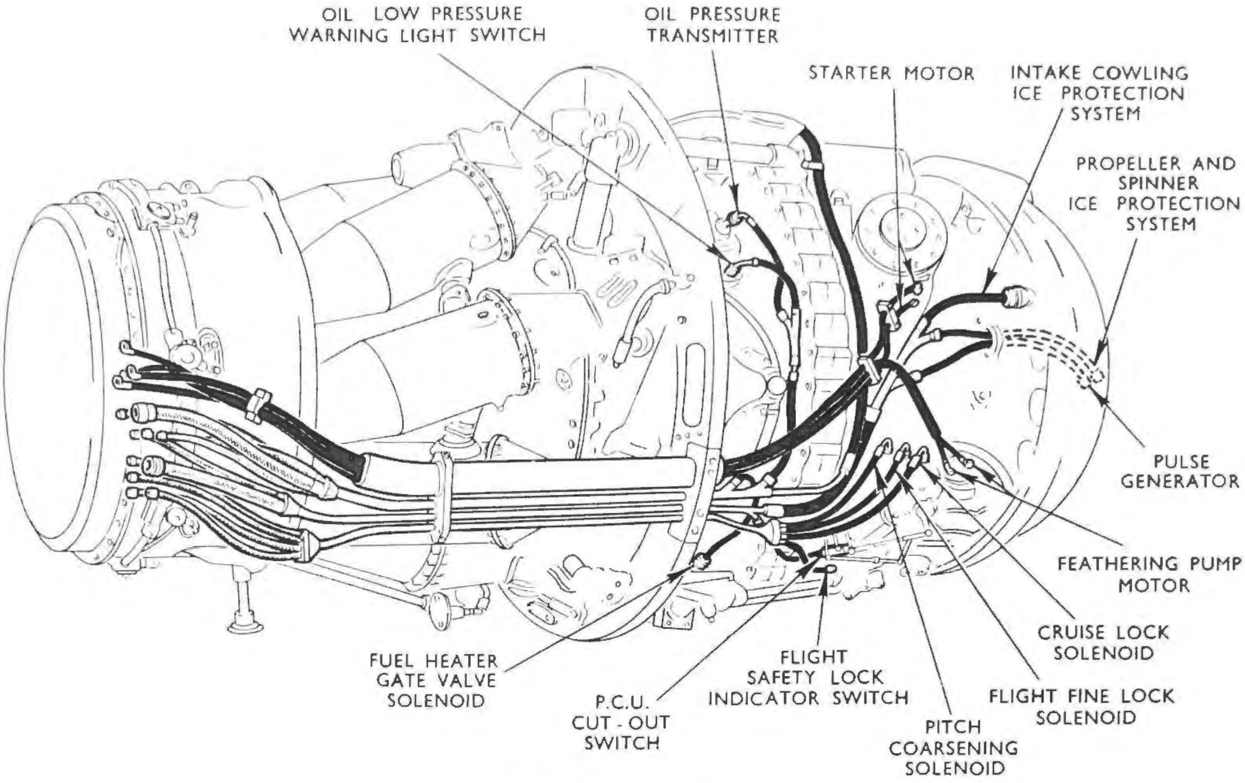
(a) Left-hand harness (Fig.202)

(b) Right-hand (upper) harness (Fig.203)

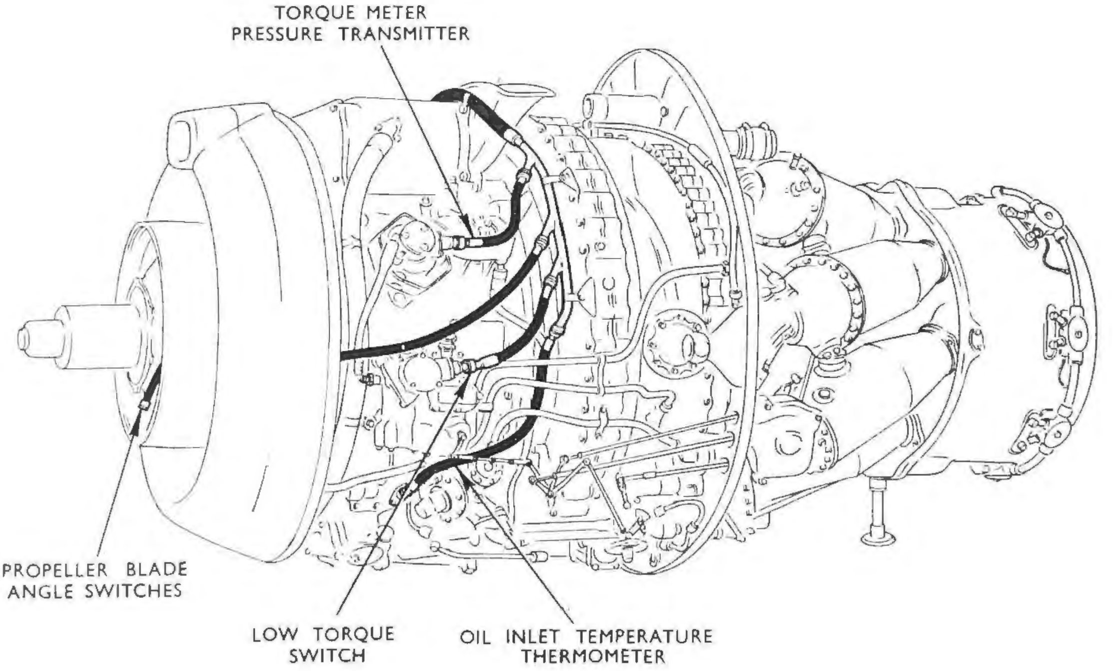
(c) Right-hand (lower) harness (Fig.204)

NOTE: On engines which feature Mod.742, the socket connection to the oil inlet temperature thermometer is replaced by a plug connection.

Low tension harness - Maintenance Practices (cont.)


OIL LOW PRESSURE WARNING LIGHT SWITCH
OIL PRESSURE TRANSMITTER
STARTER MOTOR
INTAKE COWLING ICE PROTECTION SYSTEM
PROPELLER AND SPINNER ICE PROTECTION SYSTEM
PULSE GENERATOR
FEATHERING PUMP MOTOR
CRUISE LOCK SOLENOID
FLIGHT FINE LOCK SOLENOID
PITCH COARSENING SOLENOID
FLIGHT SAFETY LOCK INDICATOR SWITCH
P.C.U. CUT-OUT SWITCH
FUEL HEATER GATE VALVE SOLENOID

Right hand – side view


TORQUE METER PRESSURE TRANSMITTER
PROPELLER BLADE ANGLE SWITCHES
LOW TORQUE SWITCH
OIL INLET TEMPERATURE THERMOMETER

Left hand – side view

G 2682

L.T. harness assembly
Fig.201

(7) Secure the socket shells by screwing down the ringnuts, then wire lock the ringnuts, using 0.028 in. diameter stainless steel wire.

(8) Ensure correct polarity then connect the starter motor and feathering pump leads lug terminals to the aircraft bulkhead and to the units concerned (Fig.205).

(9) Fit the harness supporting clips to the appropriate brackets on the engine.

2. Adjustment/Test

Whenever a harness assembly or sub-assembly has been renewed or repaired, circuit insulation and continuity checks (3. Inspection/Check) must be made before the harness is fitted to the engine.

3. Inspection/Check

A. Inspect the harness assembly

(1) Inspect the harness assembly for evidence of damage to the flexible branches, general deterioration of the rubber conduit and damage to the socket and plug connections.

(2) If damage or deterioration is evident, apply the following standards:

(a) A damaged or distorted plug or socket may be changed (4. Approved repairs) provided the harness assembly is electrically sound.

(b) Examine the lacquer film on the rubber conduit for damage or deterioration; if either is evident, touch-up or renew the lacquer film, as necessary, using Vulcaprene repair kit SQ.34(supplied by Rolls-Royce Ltd.).

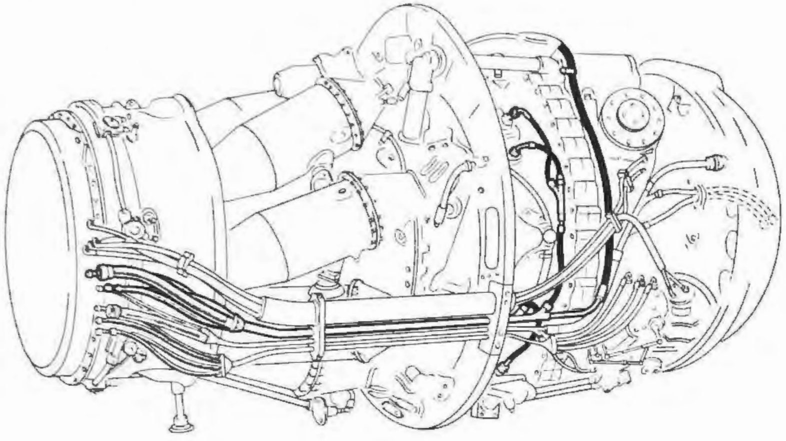
NOTE: Full instructions are included with the kit.

(c) A badly damaged branch cover may be renewed, but this is possible only with those which feature a ringnut and adapter joint, and may also involve renewing the branch cables (4. Approved repairs).

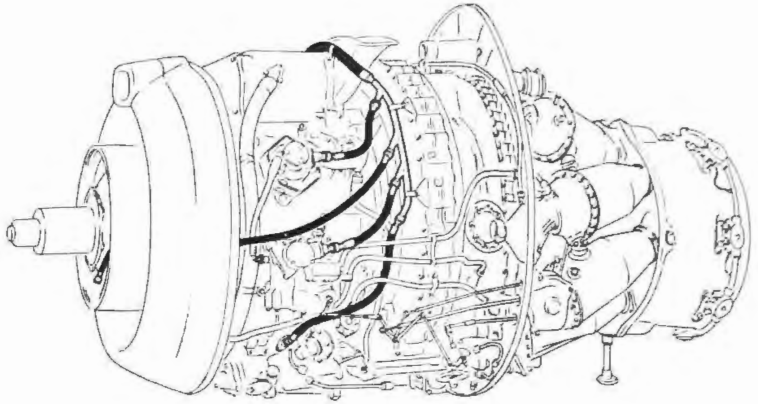
(3) If damage or deterioration affecting the harness assembly is outside the specified standards, reject the harness assembly and substitute a serviceable assembly.

NOTE: Defective starter motor and feathering pump leads are not repairable.

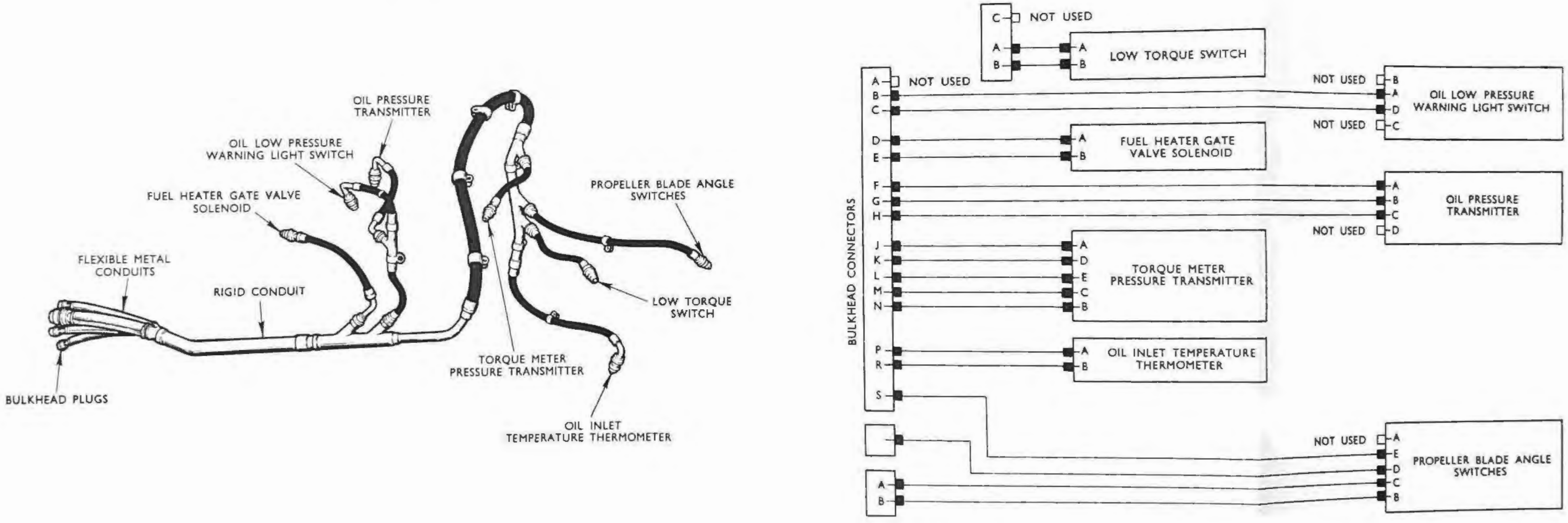
Low tension harness - Maintenance Practices (cont.)



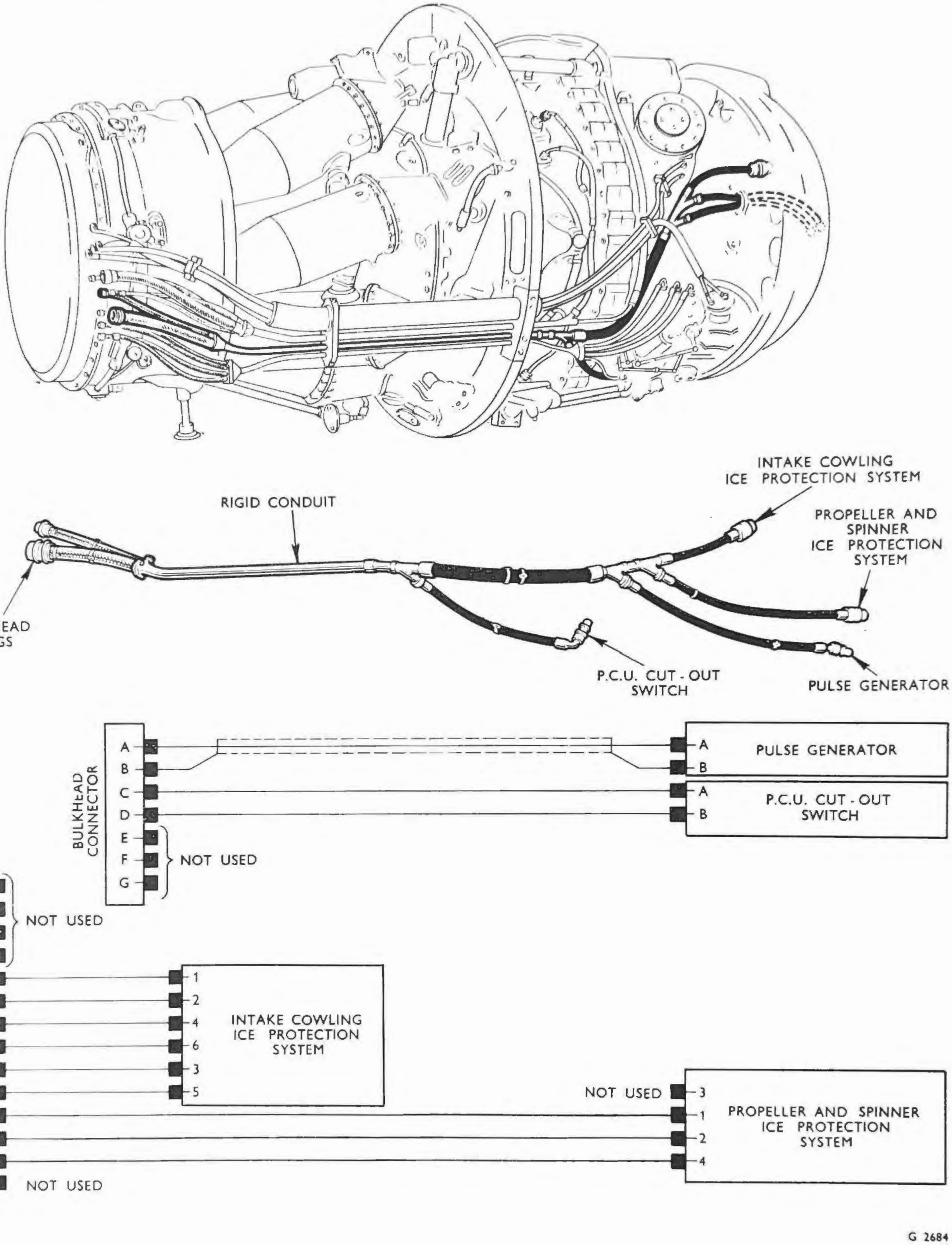
Right-hand side view



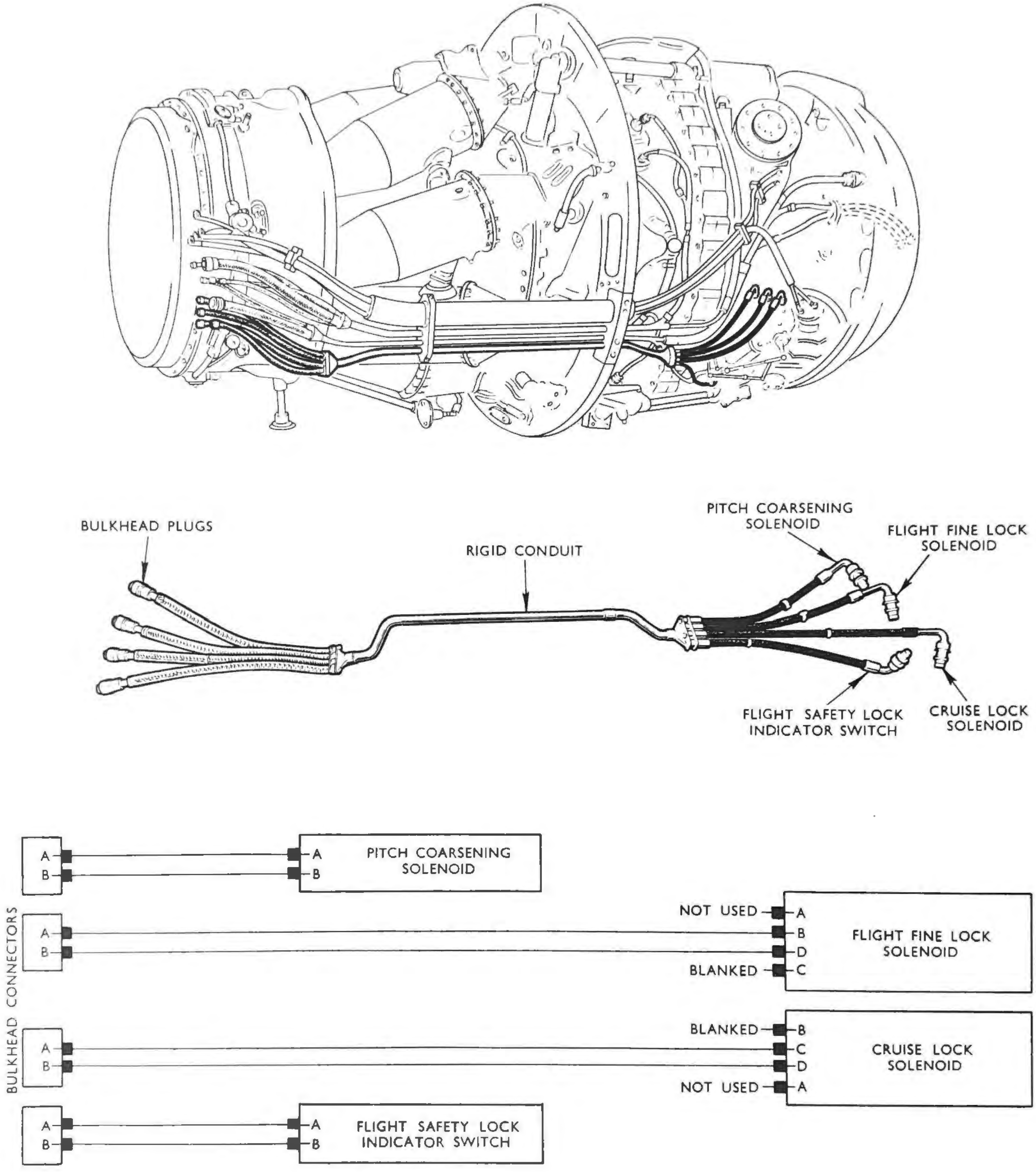
Left-hand side view


OIL PRESSURE TRANSMITTER
OIL LOW PRESSURE WARNING LIGHT SWITCH
FUEL HEATER GATE VALVE SOLENOID
PROPELLER BLADE ANGLE SWITCHES
FLEXIBLE METAL CONDUITS
RIGID CONDUIT
LOW TORQUE SWITCH
BULKHEAD PLUGS
TORQUE METER PRESSURE TRANSMITTER
OIL INLET TEMPERATURE THERMOMETER
C
NOT USED
A
B
LOW TORQUE SWITCH
BULKHEAD CONNECTORS
A
NOT USED
B
C
D
E
F
G
H
J
K
L
M
N
P
R
S
NOT USED
OIL LOW PRESSURE WARNING LIGHT SWITCH
NOT USED
FUEL HEATER GATE VALVE SOLENOID
OIL PRESSURE TRANSMITTER
NOT USED
TORQUE METER PRESSURE TRANSMITTER
OIL INLET TEMPERATURE THERMOMETER
NOT USED
PROPELLER BLADE ANGLE SWITCHES
G 2683

Left-hand harness assembly
and wiring diagram
Fig.202

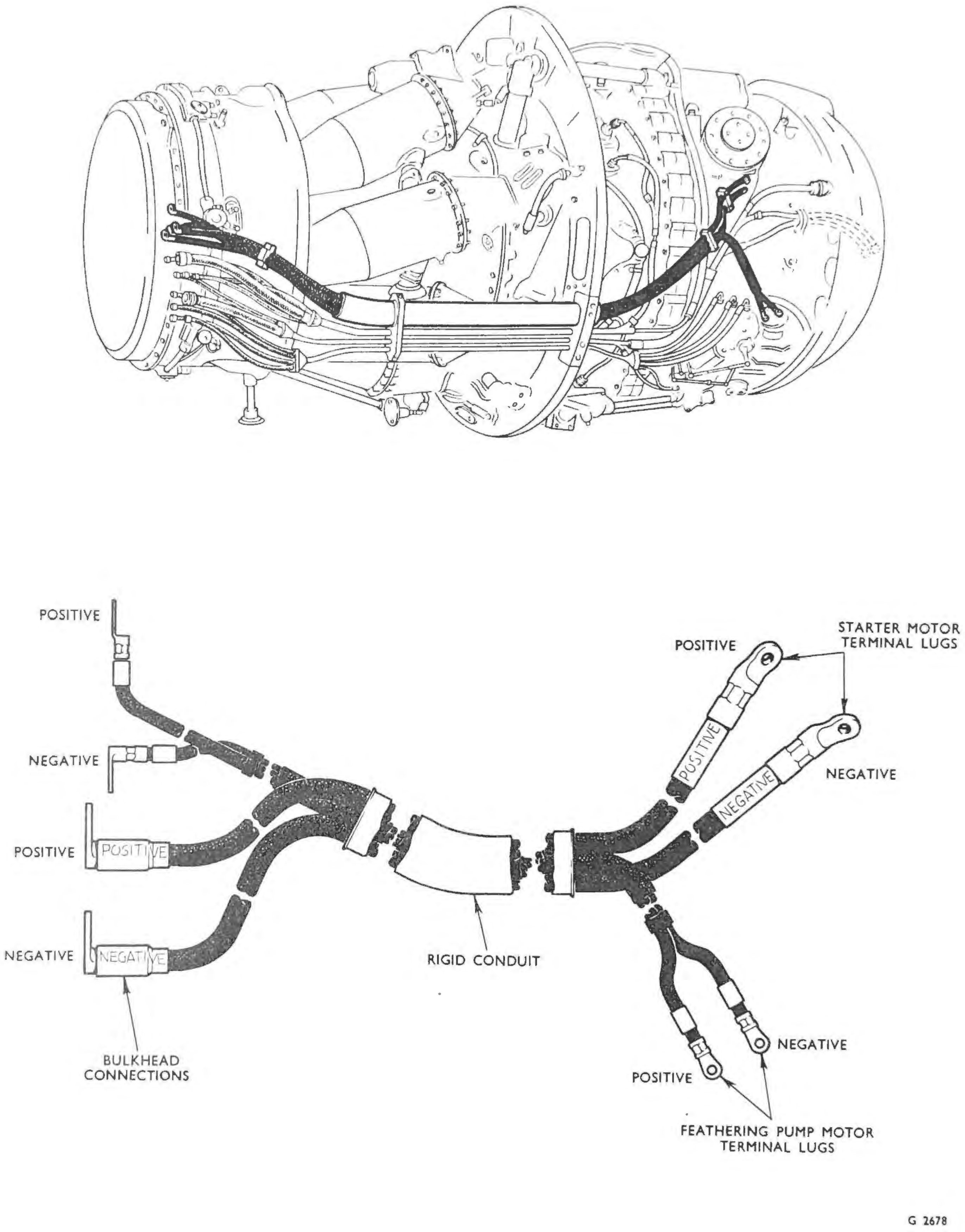


Right-hand (upper) harness assembly and wiring diagram
Fig.203


BULKHEAD PLUGS
RIGID CONDUIT
PITCH COARSENING SOLENOID
FLIGHT FINE LOCK SOLENOID
FLIGHT SAFETY LOCK INDICATOR SWITCH
CRUISE LOCK SOLENOID
BULKHEAD CONNECTORS
A
B
PITCH COARSENING SOLENOID
NOT USED
BLANKED
FLIGHT FINE LOCK SOLENOID
A
B
D
C
BLANKED
NOT USED
CRUISE LOCK SOLENOID
B
C
D
A
FLIGHT SAFETY LOCK INDICATOR SWITCH
G 2685

Right-hand (lower) harness assembly and wiring diagram
Fig.204

Low tension harness - Maintenance Practices (cont.)



Starter motor and feathering pump leads
Fig.205

B. Check insulation resistance

(1) Whenever a harness assembly or sub-assembly has been renewed or repaired, make the following insulation resistance checks before the harness is fitted to the engine.

NOTE: To facilitate the checks and prevent damage to the pins, dummy sockets, correctly wired and labelled and to which test leads can be connected, should be fitted to the harness bulkhead plugs.

(a) Using a 1,000 volt megger (insulation resistance tester, Major Megger, Evershed and Vignoles), rotate the megger handle and check that the insulation resistance between each terminal connection and the rigid conduit is not less than 20 megohms.

(b) Check the insulation resistance between each terminal connection, in turn, and the remainder in each plug wired together to form a single connection, progressively eliminating the terminals as they are checked. If the insulation resistance of one or two cables is less than 20 megohms, renew the cable (or cables) as described in 4. 'Approved repairs'. If more than two cables are affected, reject the harness assembly and substitute a serviceable assembly.

C. Check continuity

NOTE: To facilitate the checks and prevent damage to the socket inserts, dummy plugs, correctly wired and labelled and to which test leads can be connected, should be fitted to the harness sockets.

(1) Using a suitable ohmmeter (or a lamp and battery), check each cable individually for continuity; the indicated value should be zero (continuity). If one or two cables in any harness assembly are unsatisfactory, renew the cable (or cables) as described in 4. 'Approved repairs'. If more than two cables are affected, reject the harness assembly and substitute a serviceable assembly.

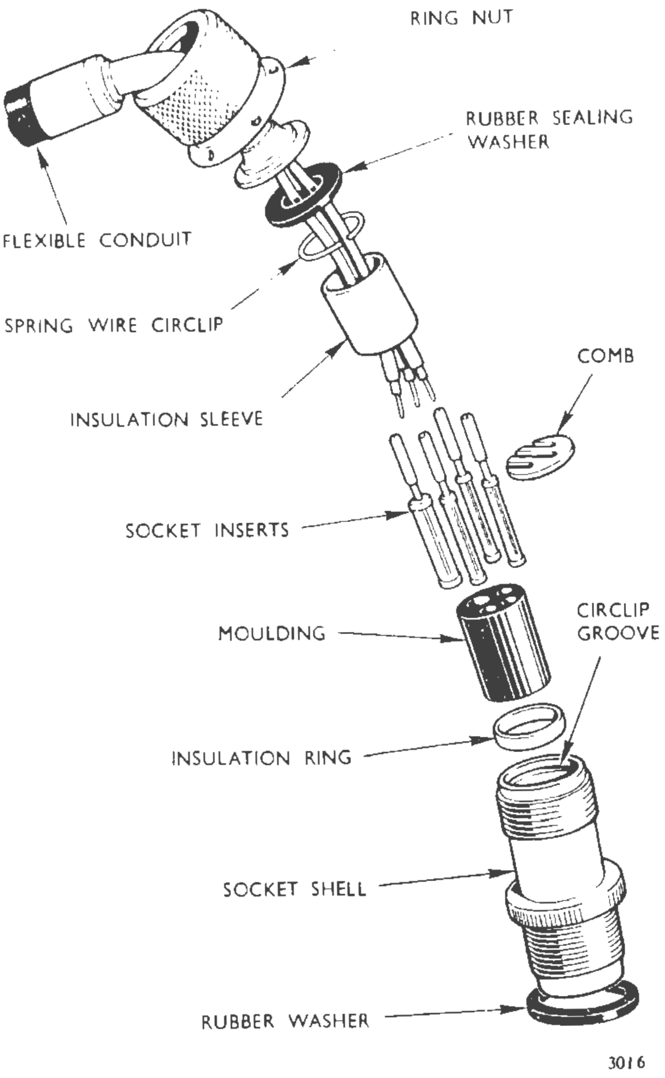
NOTE: The voltage applied to effect this check must not exceed 24 volts.

4. Approved repairs

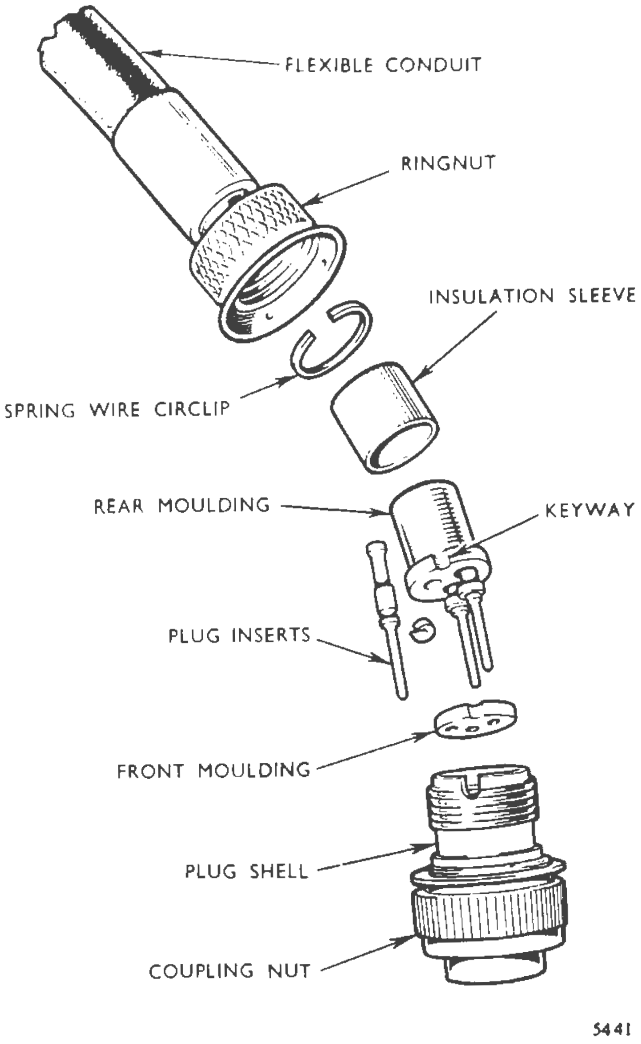
A. Effect repairs to the l.t. harness assembly within the standards specified in 3. 'Inspection/Check'.

B. Before attempting to renew a suspected faulty cable, examine the relative socket and plug for evidence of insulation breakdown (e.g. 'tracking'). To disassemble each unit for examination, remove the spring wire circlip and separate the component parts (Fig.206 and 207). A defective plug or socket connection may be replaced provided it does not serve more than two cables; in other instances, substitute a serviceable harness assembly.

Low tension harness - Maintenance Practices (cont.)



Socket connection details
Fig.206



Plug connection details
Fig.207

C. Renew the defective cable (excluding pulse generator cables)

(1) Disassemble the plug and socket and cut the socket insert and plug insert from the defective cable.

(2) Securely attach the new cable (which must be to the required specification but approximately six inches longer) to the engine end of the old cable; withdraw the old cable from the bulkhead end, thereby pulling the new cable into position. Discard the defective cable.

(3) Fit the appropriate numbered or lettered identification sleeve to each end of the new cable.

(4) Trim the cable to the required length and attach the appropriate new insert to each end of the cable. Ensure that each end of the cable attains the full depth of the bore of each insert, then crimp the inserts to secure the cable. In conjunction with the appropriate jaws, use crimping pliers AK.169 for the socket inserts, and an approved tool for the plug inserts.

(5) Check that the crimping is effective.

(6) Position the appropriate identification sleeves, equally, over the cable and the inserts.

(7) Assemble the socket and the plug.

(8) Make the insulation resistance and continuity checks specified in 3. 'Inspection/Check'.

D. Renew defective pulse generator cables (Fig.208).

(1) Proceed as described in C.(1) to (3).

(2) Comb a length of the braided-metal sheath at each end of the Tersilmetsheath No.16 cable. Of the separate wires thus obtained, twist together sufficient to form a lead of equal cross-section to that of the central lead of the cable; discard the remaining wires.

(3) Pull back the sheath and wind Scotchboy tape No.33 to cover the inner rubber coating of the cable to a length of approximately ½ in. Do not cut the tape at this stage.

(4) Push the sheath back to its original position, partially covering the tape.

(5) Pass a Blue Vidaflex S.200 (silicone rubber coated glass) sleeve over the single braid formed in (2).

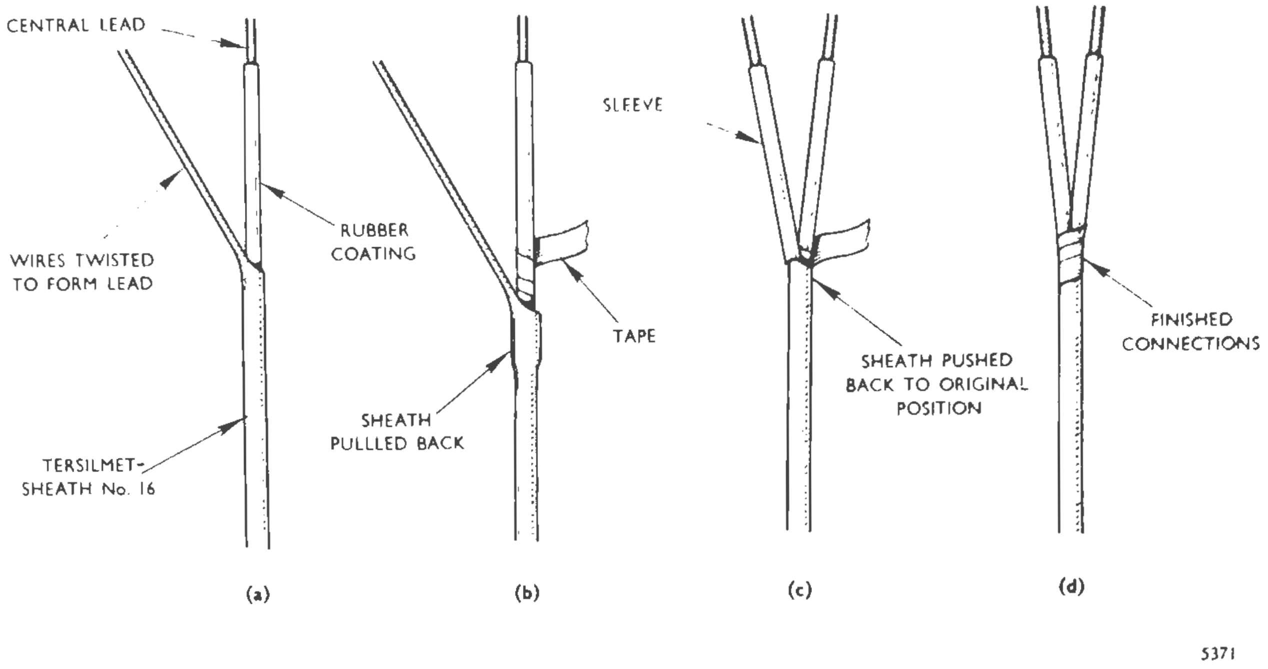
(6) Continue winding the Scotchboy tape to cover the sleeve, and the braided-metal sheath, to a length of approximately ½ in., then cut the tape.

(7) Proceed as described in C.(4) to (8).

E. Renew a defective socket or plug

(1) Proceed as described in C.(1) to (8) or D.(1) to (7), as appropriate.

NOTE: When renewing a plug or socket it may not be necessary to renew the cable, as there may be sufficient 'hidden' cable to allow a recrimping operation.



Pulse generator screened lead terminations
Fig.208

F. Renew a branch conduit

NOTE: These instructions apply only to the left-hand harness assembly and the right-hand (upper) harness assembly.

(1) Remove the socket as described in C.(1).

(2) Sever the locking wire, unscrew the ringnut which secures the branch to the main conduit adapter and remove the branch conduit.

(3) Fit the replacement branch to the main conduit adapter and wire lock the ringnut, using 0.028 in. diameter stainless steel wire.

(4) Proceed as described in C.(4) to (8).

APPENDIX 2

R.P.M. DIGITAL INDICATOR

1. General

A. The following equipment is required to effect r.p.m. measurement:

(1) R.P.M. digital indicator - ERE.2380)
) Refer to Fig.1
(2) Connecting lead - ERE.2382)

(3) Indicator test lead - ERE.2384

(4) Battery charger - ERE.2313) Refer to Fig.2

B. Use the bench mounted battery charger, to charge the digital indicator battery whenever required. Refer to Fig.2.

2. Check the r.p.m. digital indicator

CAUTION: TO AVOID DAMAGE TO THE R.P.M. DIGITAL INDICATOR, THE TEST LEAD HAS RESISTORS FITTED TO THE CANNON PLUG AND ONLY THE LEAD SUPPLIED MUST BE USED.

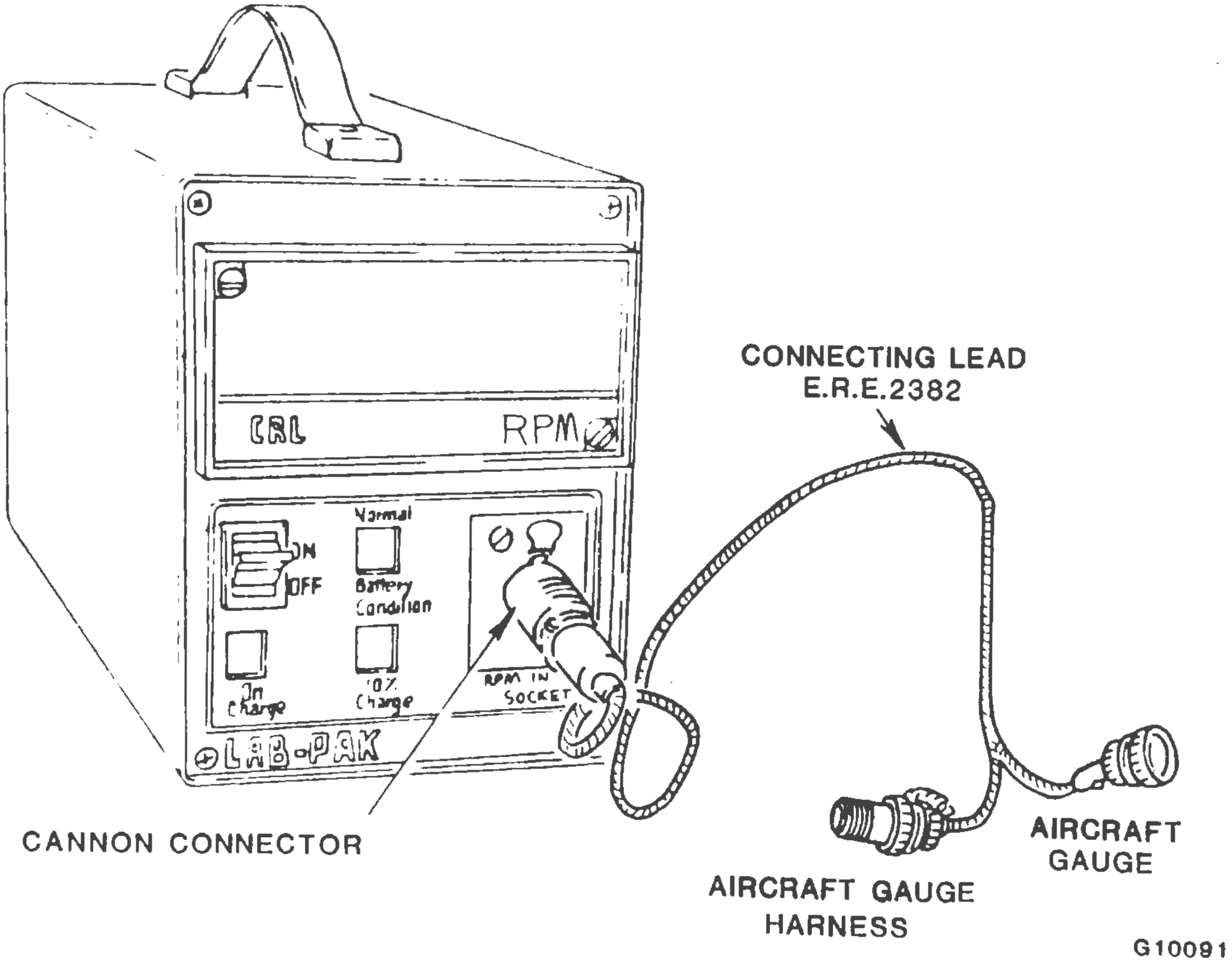
A. The test lead, ERE.2384, is provided to check that the r.p.m. digital indicator is operative. The lead connects to the local electrical supply (100 volts to 250 volts, single phase, 50/60 HZ) and will indicate immediately as follows:

50 HZ = 12,000 r.p.m.

60 HZ = 14,400 r.p.m.

NOTE: Any slight variance in r.p.m. reading will indicate fluctuations in mains frequency.

R.p.m. digital indicator (cont.)



R.p.m. digital indicator
Fig.1

R.p.m. digital indicator (cont.)

B. If an indicator fails to meet the specified conditions, repairs are possible with the aid of a Technical Manual, available from the manufacturer at the following address:

Control and Readout Limited
Woods Way
Goring-by-sea
Worthing
West Sussex BN12 4TH
England

C. If it is not possible to adjust the indicator within limits and repair facilities are not available, return the indicator to:

Ground Support Equipment Store
'V' Block
Rolls-Royce Limited
East Kilbride G74 4PY
Scotland

3. Charge the r.p.m. digital indicator battery

A. Before proceeding with the battery charging technique, check the following:

(1) The mains voltage selector switch on the back of the charger is set to the correct voltage supply.

(a) Set to '115' for '110 - 115 volts'

(b) Set to '230' for '230 - 240 volts'

(2) A suitable fused mains plug is connected as follows:

(a) Brown wire to 'LIVE' terminal.

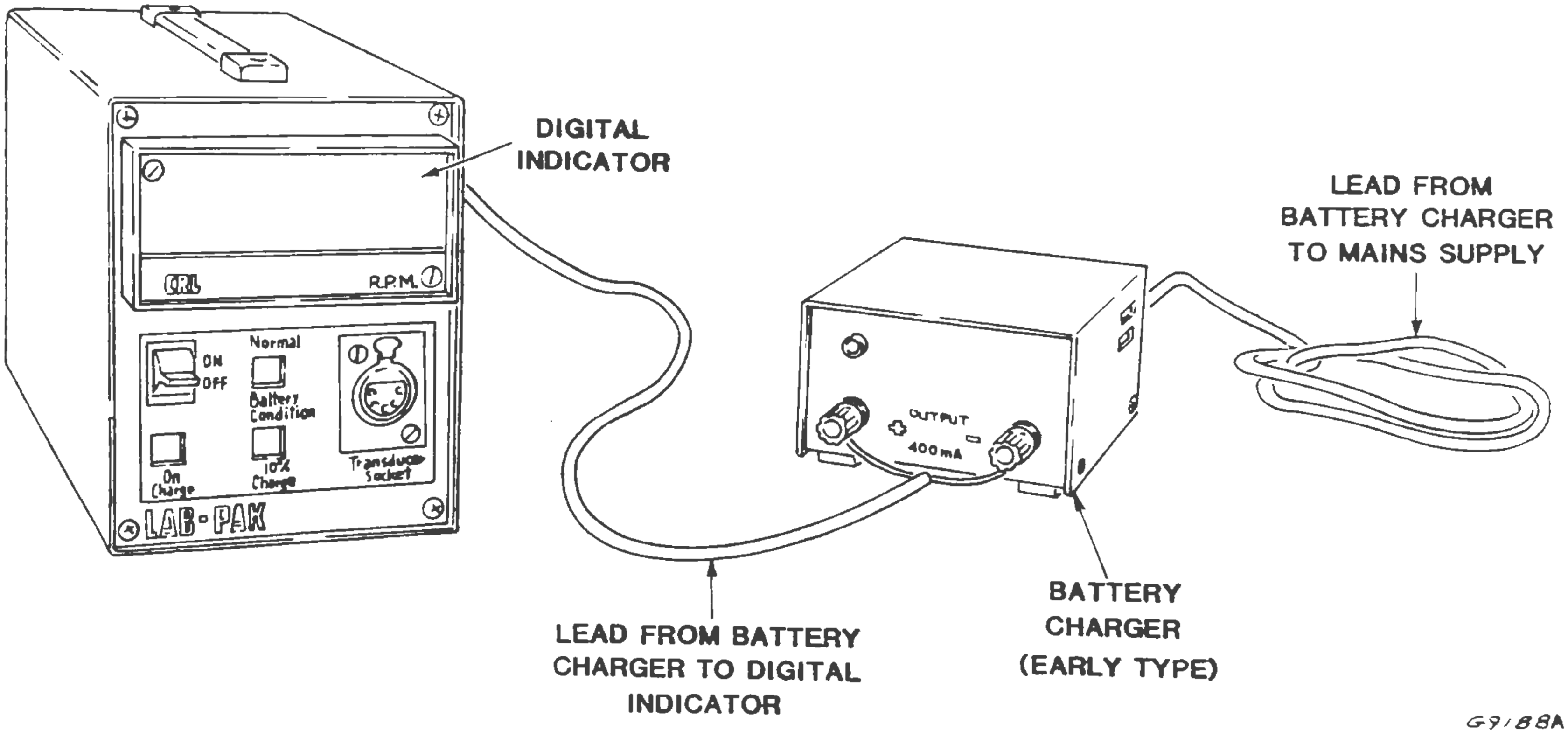
(b) Blue wire to 'NEUTRAL' terminal.

(c) Green/yellow wire to 'EARTH' terminal.

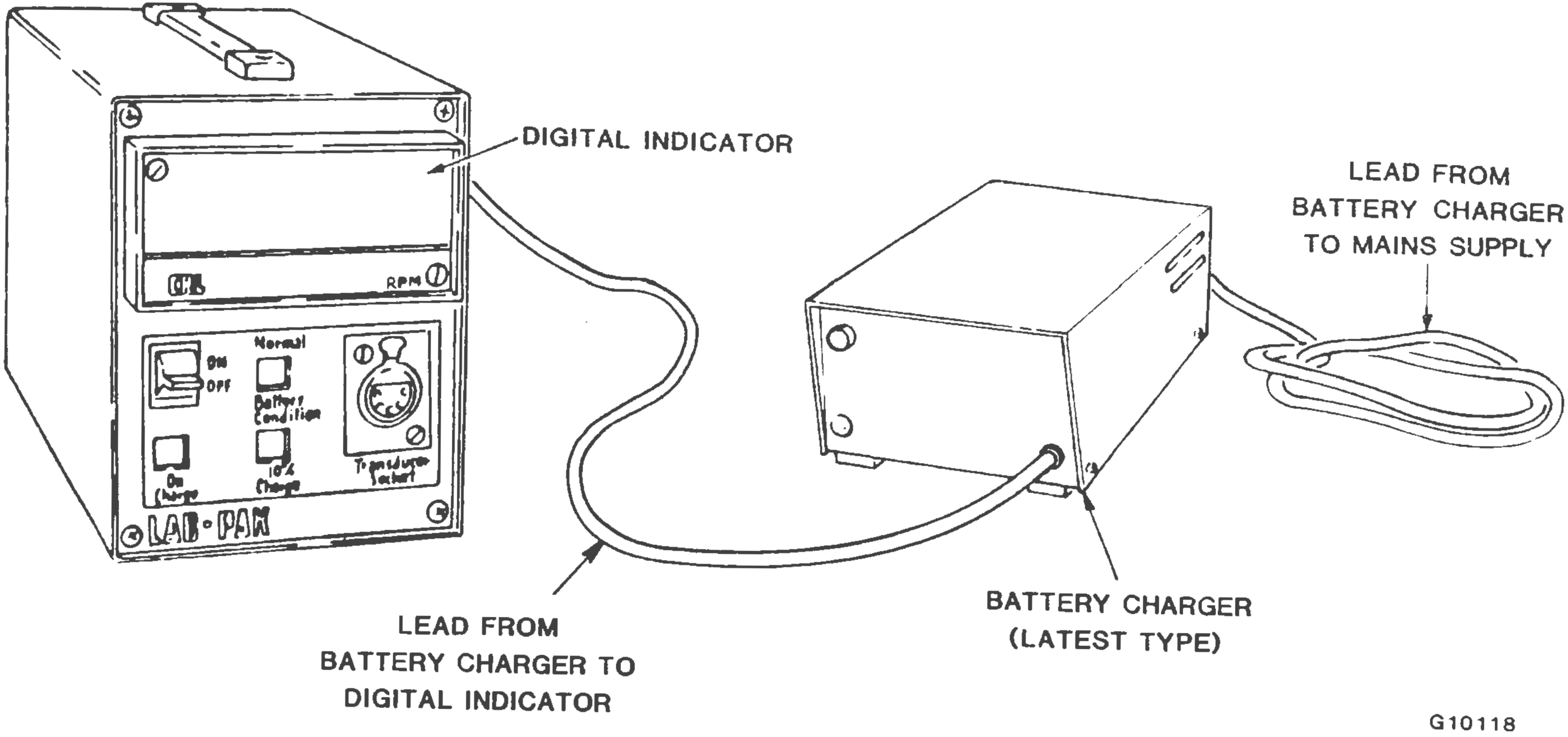
(3) The fused mains plug is fitted with a 2 or 3 amp. fuse.

(4) The charger is fitted with a 1 amp. quick-blow, 20 mm. x 5 mm. fuse.

(5) The red neon light, on the charger, illuminates when the mains supply is on.


DIGITAL INDICATOR
CRL
R.P.M.
ON
OFF
Normal
Battery Condition
On Charge
10% Charge
Transducer Socket
LAB-PAK
OUTPUT
400 mA
LEAD FROM BATTERY CHARGER TO MAINS SUPPLY
LEAD FROM BATTERY CHARGER TO DIGITAL INDICATOR
BATTERY CHARGER (EARLY TYPE)
G9188A

R.p.m. digital indicator
and battery charger
Fig.2


DIGITAL INDICATOR
LEAD FROM BATTERY CHARGER TO MAINS SUPPLY
LEAD FROM BATTERY CHARGER TO DIGITAL INDICATOR
BATTERY CHARGER (LATEST TYPE)
RPM
ON
OFF
Normal
Battery Condition
On Charge
10% Charge
Transducer Socket
LAB-PAK
G10118

R.p.m. digital indicator
and battery charger
Fig.2A

R.p.m. digital indicator (cont.)

B. Connect the battery charging lead(s)

(1) Early type. Refer to Fig.2

(a) Brown wire to the 'RED' terminal ('+' on charger).

(b) Blue wire to the 'BLACK' terminal ('-' on charger).

(c) Connect the 4 pin connector on the other end of the charging lead to the socket on the rear panel of the digital indicator.

(2) Latest type. Refer to Fig.2A.

(a) Connect the 4 pin connector to the socket on the rear panel of the digital indicator.

CAUTION: ENSURE THAT THE DIGITAL INIDCATOR IS SWITCHED OFF DURING THE CHARGING PROCEDURE AS IT CONSUMES NOMINALLY THE SAME POWER AS THE CHARGER DELIVERS. THEREFORE CHARGING WILL NOT TAKE PLACE IF THE INDICATOR IS SWITCHED ON.

C. Connect the charger to the mains supply, then switch on the power source. The red neon light on the charger and the 'On Charge' on the digital indicator will illuminate.

D. A full charge will take approximately 14 hours.

NOTE: Moderate overcharge will not cause damage, but this must not normally exceed 24 hours at the normal charge rate.

E. Switch off the mains supply, then disconnect the charger by removing the charging lead 4 pin connector from the rear panel of the digital indicator.

CHAPTER 72 - ENGINE

LIST OF ROLLS-ROYCE EFFECTIVE PAGES

This chapter consists of the following pages

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9	May 31/58
10	May 31/58
11	May 31/58
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13	July 31/58
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303	Aug.19/68
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306	Jan.31/72
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308	July 84
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702	Oct.82
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717	Oct.81
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204	Aug.80
205	Aug.80
206	Aug.80
207	Aug.80
208	Aug.80
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204	Oct.82
(R) 204A	Oct.84
(R) 204B	Oct.84
(R) 204C	Oct.84
(R) 204D	Oct.84
(R) 205	Oct.84
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210	Mar.21/66
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212	May 1/64
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3	Mar.31/58

CHAPTER 82 - WATER INJECTION

LIST OF ROLLS-ROYCE EFFECTIVE PAGES

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	204	Aug.82
	205	Aug.82
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	212	Nov.78
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	203	May 27/68

Water/methanol system - Description and operation (cont.)

Refer to the first paragraph and Fig.1 on page 1. On Mk.551 and Mk.552 engines and engines featuring either Mod.1850 or Mod.1860 the water/methanol fluid passages in the first-stage impeller assembly are deleted and the water/methanol is injected into the compressor from radially drilled holes in the first-stage impeller retaining nut.

DESCRIPTION

ENGINE

MAIN FEATURES

The 520 Series Dart is a propeller turbine aero-engine in which the propeller and the two-stage centrifugal compressor are driven by a three-stage turbine. The compressor is directly coupled to the turbine and the propeller is driven from a separate turbine shaft through a compound reduction gear.

The operating cycle is a continuous process which consists of compressing air, then expanding it by combustion to provide the high velocity gas stream which drives the turbine.

Air entering the air intake duct is directed into the first stage of the compressor assembly where the pressure is initially raised, then passed into the second stage where the pressure is raised further. On leaving the compressor, through elbows attached to the rear casing, the air is directed into the combustion chambers where fuel is added by injection. The mixture is ignited and the resulting flow of rapidly expanding gases pass through the turbine, where guide vanes direct the flow to impinge on the turbine blades.

Most of the energy in the expanding gases is absorbed by the turbine in driving the compressor and the propeller; some useful energy, however, remains in the exhaust gases and produces a small amount of thrust by reaction.

MAIN CASINGS

The main structure of the engine is formed by a number of basically circular castings secured together by flanged joints to form a rigid structure, inside which the main rotating assembly is supported by ball and roller bearings and a plain bearing. The casings are accurately located by radially positioned dowels, spigots and close-fitting bolts.

Each casing is manufactured from the lightest material which will withstand the stresses and temperatures to which it is subjected in use. Magnesium alloy is used for the air intake casing, the compressor front casing and the intermediate casing where high temperatures are not encountered; aluminium alloy is used for the main compressor casing which is subject to intermediate temperature and transmits the thrust of the engine to the airframe. Heat-resisting steels are used for the flame tubes, nozzle box, turbine assembly and the exhaust unit.

The intermediate casing attaches to the compressor outlet casing and carries at its rear end the nozzle box and turbine bearing housing. A compartment at the forward end houses a train of spur gears which drive the accessory gearbox and the centrifugal beather.

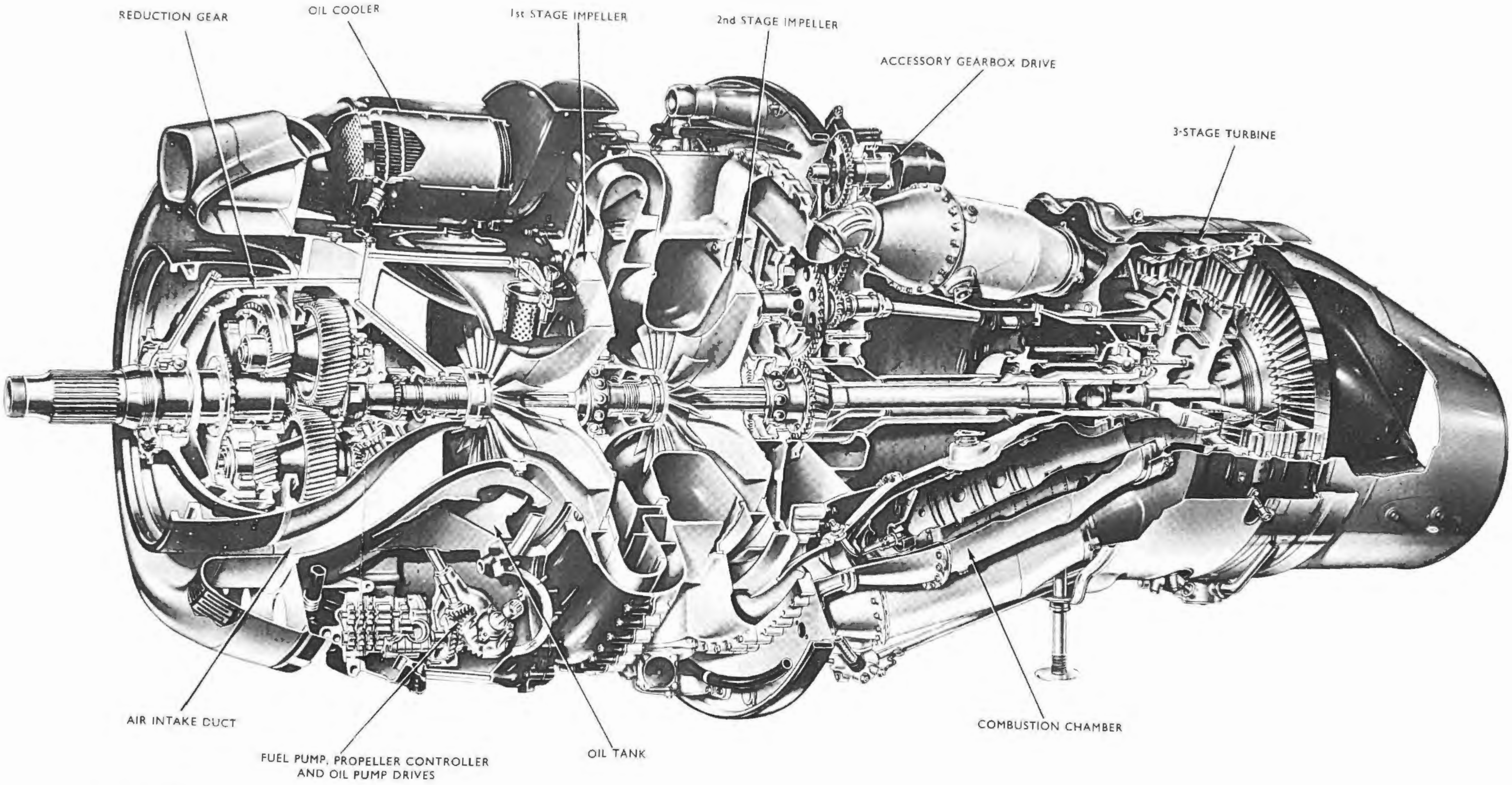


Fig. 1 Dart 520 Series engine

2610

ROTATING ASSEMBLY

The compressor rotors are directly driven from the turbine through a splined coupling shaft. To prevent over-speeding in the event of a shaft failure, the drive to the propeller is transmitted from the turbine to the propeller reduction gear by a separate shaft, which passes through the hollow compressor drive shafts to the reduction gear high-speed pinion.

The outer shafts of the rotating assembly are supported by three ball thrust bearings, a roller bearing and a plain bearing. A steady bush is in contact with the inner drive shaft.

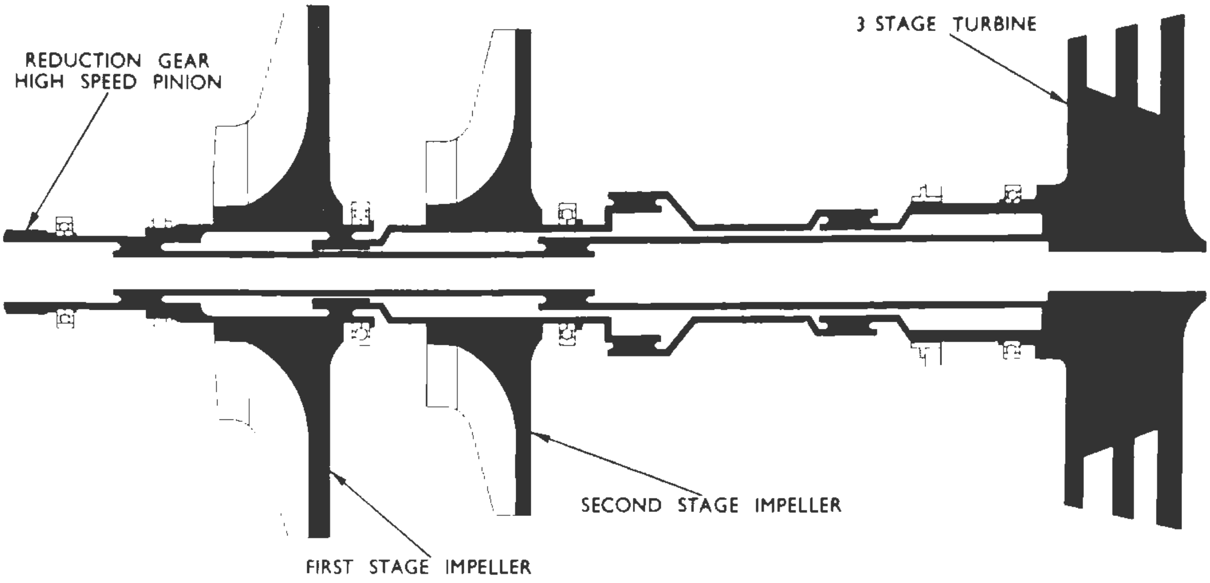


Fig. 2 Rotating assembly

REDUCTION GEAR

The drive from the turbine shaft to the propeller is transmitted, via the high-speed pinion, through a triple layshaft assembly to the rotating annulus gear bolted to the propeller shaft. Helical teeth are used throughout the train, the forward axial thrust of the layshafts being opposed by oil pressure acting on a piston face at the forward end of each layshaft. The oil pressure required to balance out the layshaft axial thrust is measured to provide an indication of engine power and is known as torque meter pressure. This pressure oil is supplied by a gear-type pump incorporated in the reduction gear.

The lower layshaft also transmits the drive to the bevel gear assembly which is situated in the lower section of the air intake casing. The oil pump, the propeller controller and the fuel pump are each driven by an output drive shaft from the bevel gear assembly.

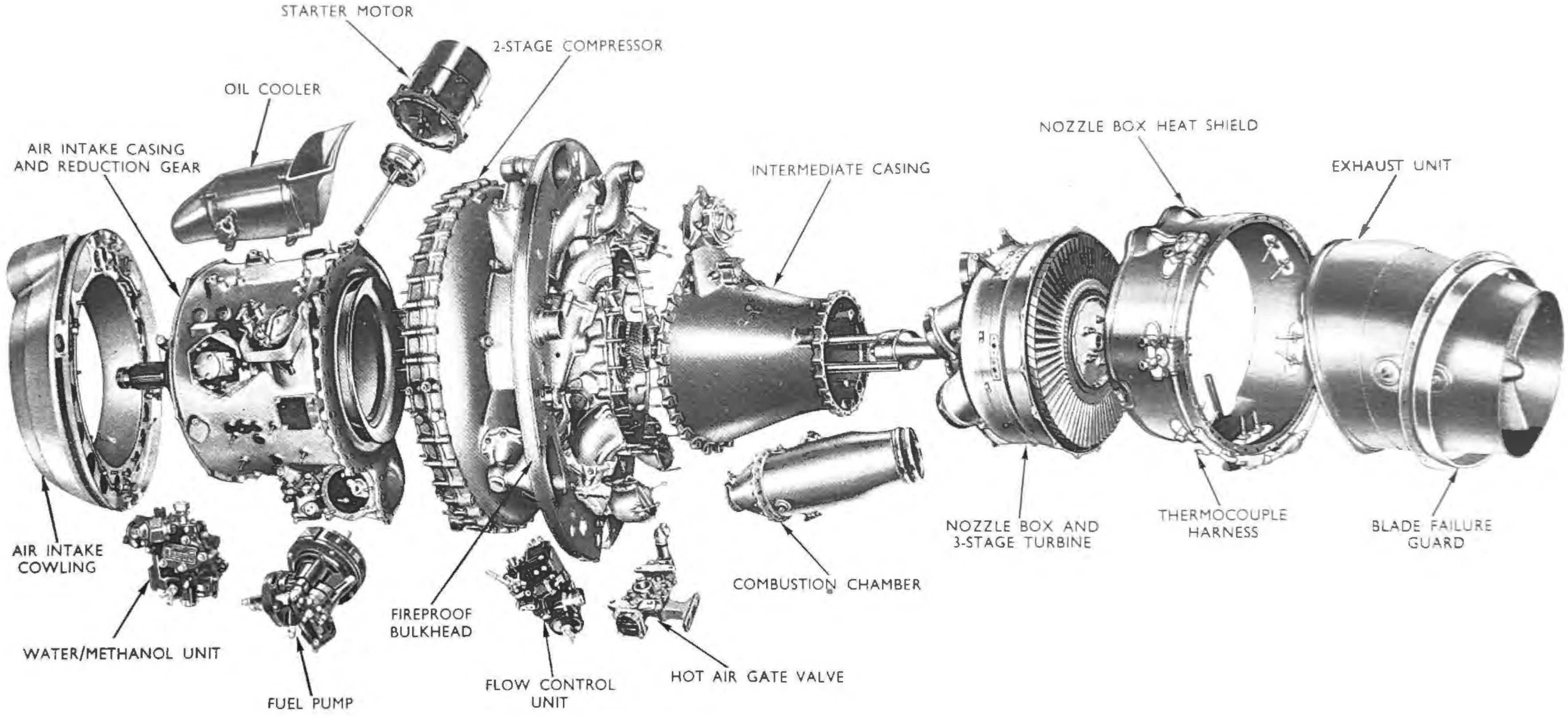


Fig. 3 Engine main units

AIR INTAKE

The air intake casing embodies a large annular duct which directs air to the compressor; the reduction gear is centrally mounted in the intake duct on radial webs. Also embodied in the casing are the annular oil tank and the bevel gear housing.

A nose cowling fitted to the front of the air intake has an integral entry duct for airflow through the oil cooler and carries insulated electrical de-icing elements as described in 72-1.

FUEL SYSTEM

The fuel system controls the supply of fuel to the burner sprays in the combustion chambers, thus maintaining a correct fuel/air ratio throughout the engine operating range.

Fuel supplied to the engine passes through a low pressure filter, then enters the engine-driven fuel pump which has a variable output controlled by a servo system, as described in 73-0. The pump delivers fuel as a high pressure flow through the controlling throttle valve to the burners.

COMBUSTION EQUIPMENT

The combustion equipment consists of seven combustion chambers which are grouped around the intermediate casing between the second-stage compressor and the turbine nozzle box.

Each combustion chamber contains a flame tube and a burner. The burner directs a fine spray of fuel into the centre of the flame tube where the air and fuel mixture is burnt.

A high-energy igniter is positioned in each of two chambers and provides the initial combustion of the burner spray when starting, the flame being spread to the remaining chambers through interconnector tubes.

OIL SYSTEM

The engine pressure oil system is self-contained on the engine.

Oil is supplied from the annular oil tank in the intake casing to a gear-type pump which delivers pressure oil for circulation to various points throughout the engine for lubrication purposes and for the operation of the propeller pitch mechanism, the water/methanol unit and the torque meter.

Oil leakage from the bearings is prevented by air pressurized thread-type oil seals.

A reserve of oil is maintained within the oil tank for use by the feathering pump.

Scavenge oil is returned by four scavenge pumps and delivered through the oil cooler back to the annular supply tank.

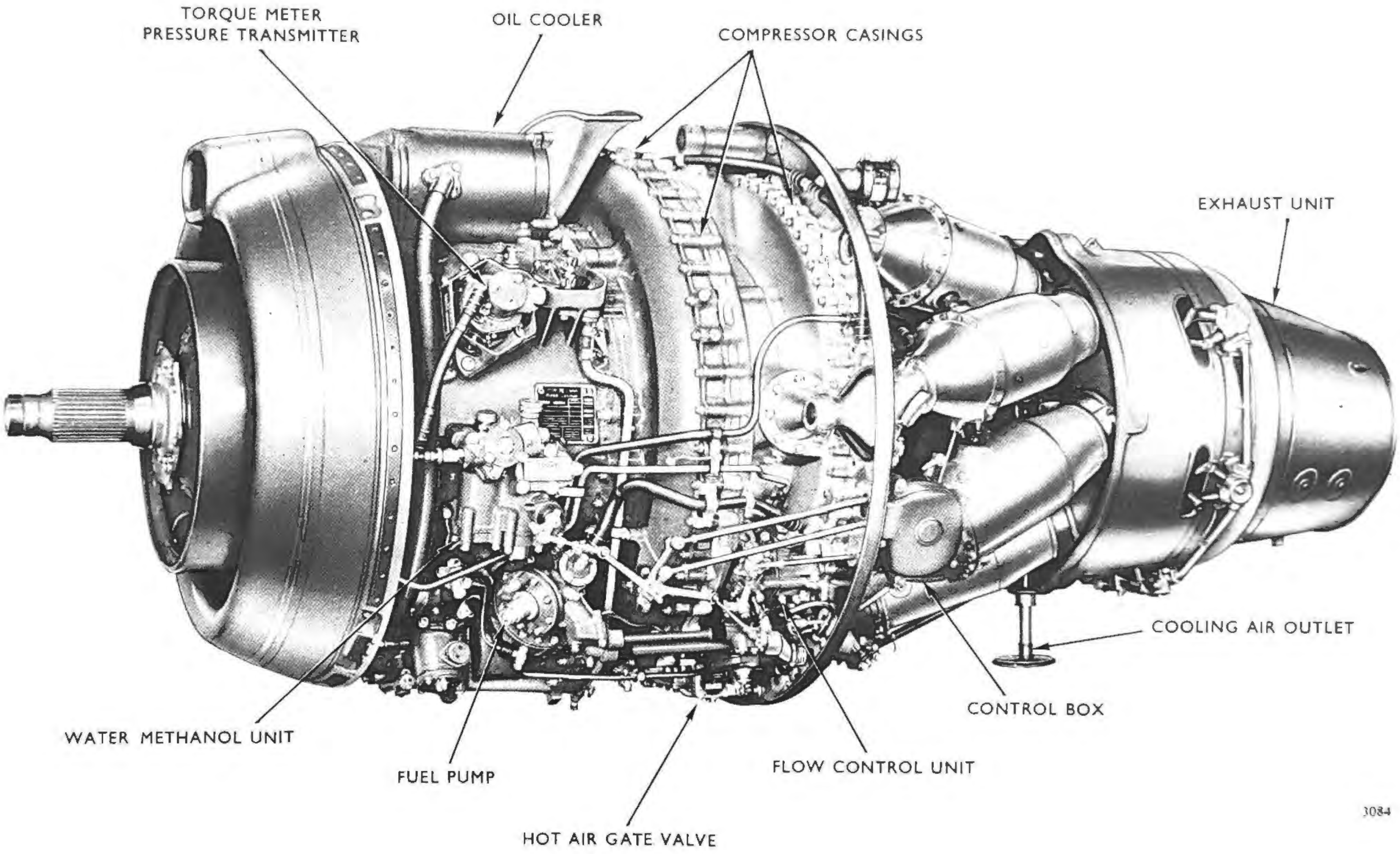


Fig. 4 Dart 520 Series engine – port view

SUBSIDIARY AIRFLOWS

Air is tapped from several points around the compressor and ducted to various parts of the engine, where it is utilized to counteract the spread of heat throughout the engine from the main gas stream, to pressurize labyrinth seals and to purge the water/methanol passages.

When required, hot air is bled from the second-stage compressor for supply to the fuel filter de-icing system.

GAS SEALS

Where it is necessary to form a gas seal between a static and a rotating member, a labyrinth seal is used. The seal is not airtight but forms a controlled restriction to the passage of gas or air. In some cases, air tapped from the compressor is used to pressurize the seal and control the direction of leakage.

OPERATION AND CONTROL

The operating principle of the Dart propeller turbine is a continuous process, consisting of:

(1) taking in and compressing air

(2) adding fuel and burning it with the air to increase the total energy of the airflow

(3) discharging the expanding gases to atmosphere through a turbine to produce shaft horse-power to drive the propeller as well as the compressor.

(4) using the energy remaining in the turbine exhaust gases to give a small jet thrust.

The proportion of energy between shaft power and jet thrust is arranged to give the optimum total effective thrust for the particular application of the engine.

The greater part of the power developed by the turbine is used to drive the compressor. A small amount is absorbed by the auxiliaries and by the low friction losses. The remainder, which at maximum power conditions is about one-third of the turbine power, is available to drive the propeller.

To the propeller shaft horse-power is added the effect of the residual jet thrust to give the 'total equivalent horse-power' (t.e.h.p.). The power required by accessories driven through the accessory gearbox must be deducted from this total.

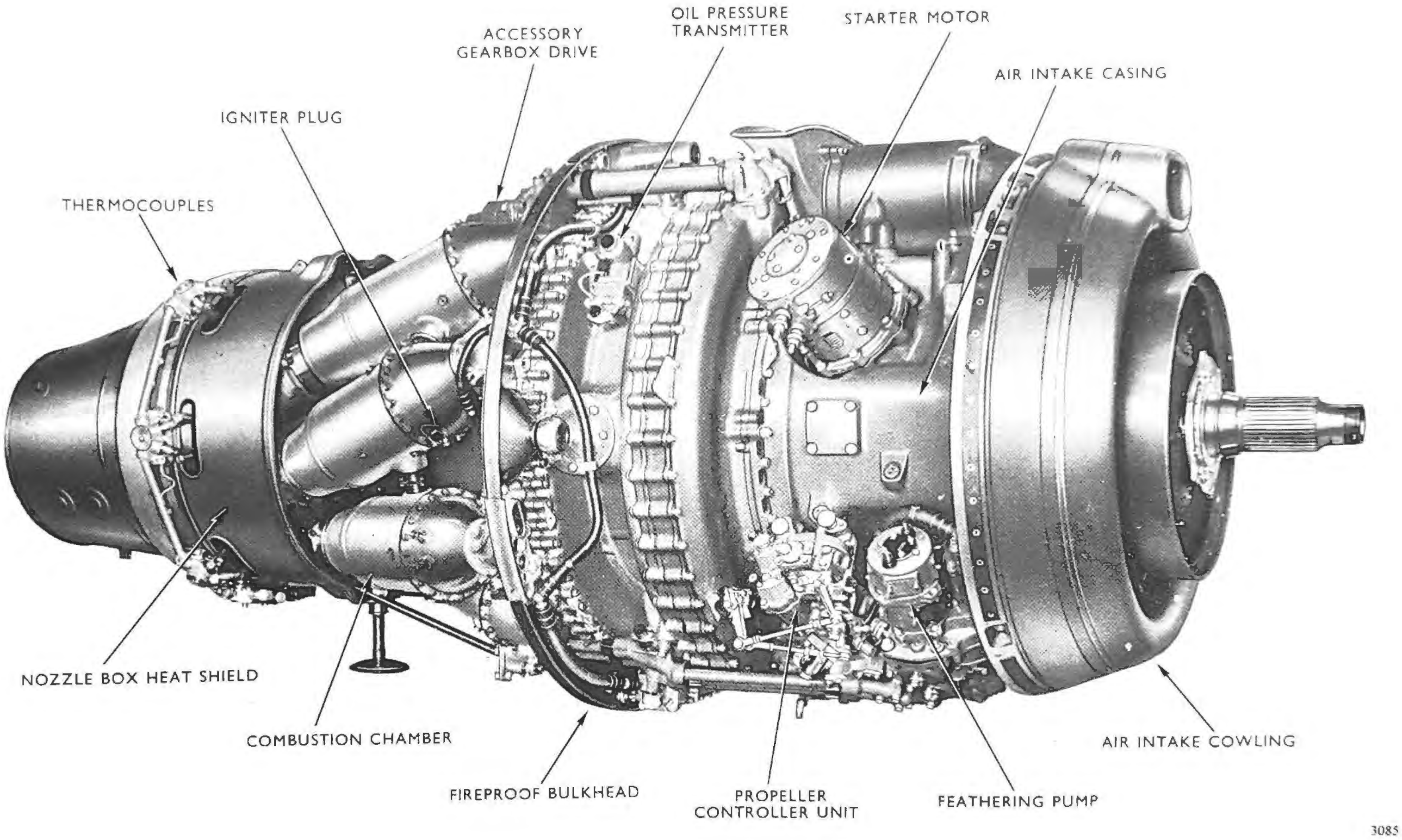


Fig. 5 Dart 520 Series engine – starboard view

The power developed by the turbine is dependent on two factors air mass flow and temperature drop.

Air mass flow — This varies with engine r.p.m. and also with the air density, which is determined by altitude, atmospheric air temperature and forward speed.

The air/fuel ratio of the Dart over the cruising and high power range is between 60 : 1 and 70 : 1; a higher ratio is reached over the lower speed range.

Temperature drop — Thermocouple readings of the gas temperature immediately before and after the turbine would give the drop in 'total temperature' and so measure the energy extracted by the turbine.

This temperature drop will be a maximum, indicating the maximum energy extraction, if the gas temperature at the turbine entry is maintained at the highest practicable level. The aim is, therefore, to operate the engine at as near as possible to the maximum turbine entry temperature consistent with engine reliability and life considerations. There is a limiting turbine entry temperature for each of the engine operating conditions: Take-off, Maximum Continuous, and Cruise.

A low outside air temperature will assist in securing the maximum temperature drop across the turbine and in fact the engine operates most efficiently — i.e. gives the most power for the fuel consumed — at low air intake temperature, provided that there is sufficient fuel to maintain the turbine entry temperature.

For given atmospheric conditions, the air mass flow through the engine is determined by engine r.p.m. Engine speed is controlled to any selected r.p.m. between Take-off r.p.m. and the Approach Idling r.p.m. by a propeller controller unit and variable pitch propeller.

Fuel flow is controlled by the throttle valve and must be matched to the air mass flow to maintain but not exceed the maximum turbine entry temperature applicable to the particular engine operating condition. The propeller speed control and throttle valve are therefore interconnected to give the pilot a single lever control of engine power. This arrangement provides a progressive power response to all movements of the pilot's lever; the method by which this is done is described in 76-0 under 'Control System.'

The gas temperature gauge, calibrated in deg.C., and the engine r.p.m. indicator are the main instruments used when controlling the engine. A torque meter pressure gauge, calibrated in lb. per sq. in., is also fitted and gives a supplementary indication of propeller shaft horse-power.

Because of difficulties in recording the gas temperature at the actual point of turbine entry, the measuring thermocouples are in practice located in the intermediate pressure nozzle guide vanes of the three-stage turbine. The temperature so recorded is the 'turbine gas temperature' (T.G.T.) and it bears a sufficiently accurate relationship to the turbine entry temperature to enable it to be used for all ordinary control and operational purposes.

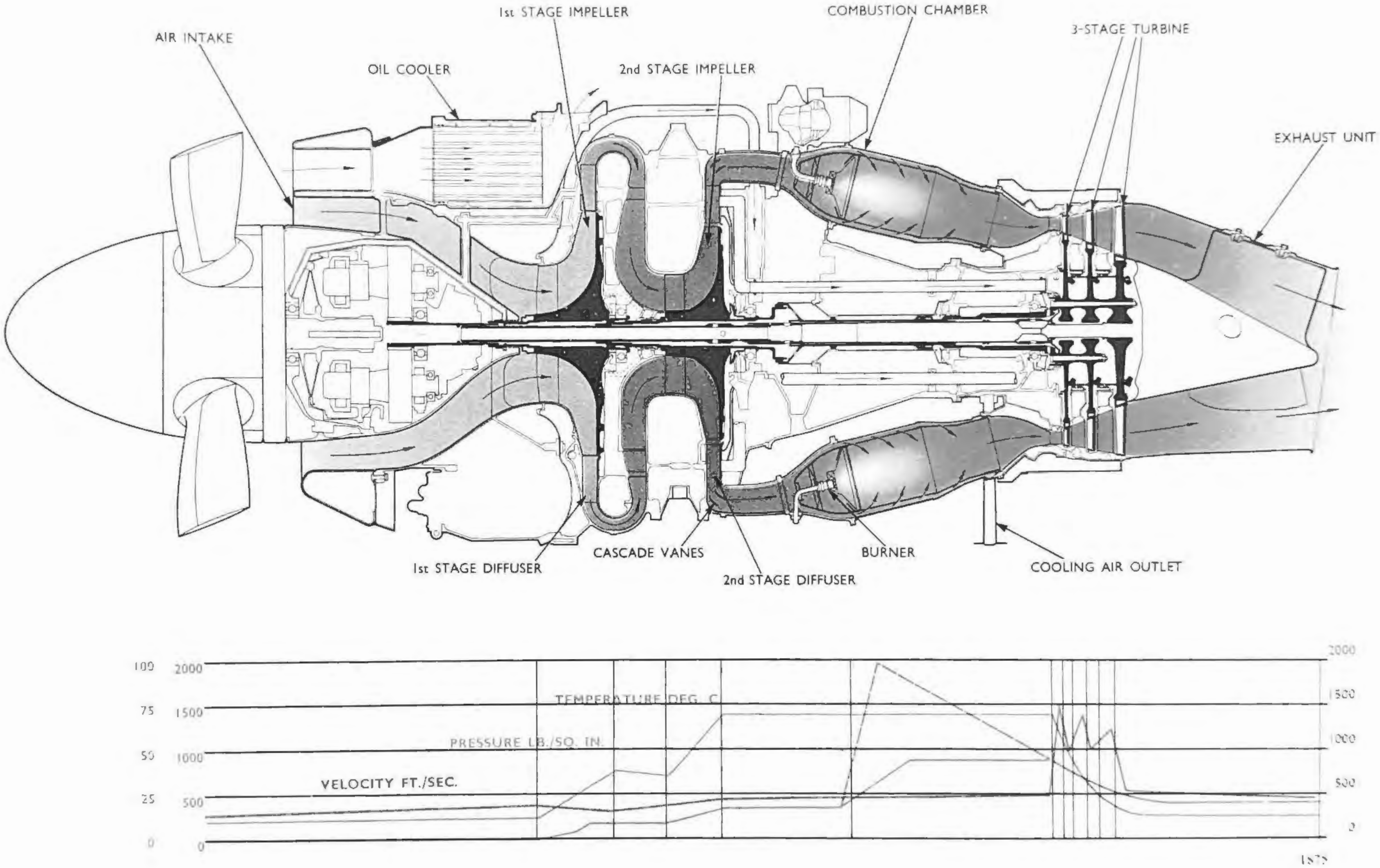


Fig. 6 Gas flow diagram

CONTROL OF ENGINE POWER

During starting and at low engine speeds on the ground, nearly all the turbine power is required to drive the compressor (fig. 7). The propeller is therefore designed to be at appoximately zero pitch, on its 'ground fine pitch stop.'

As the pilot's power control (throttle) lever is opened from its ground idling position, the propeller remains on this ground fine pitch stop whilst the engine speed increases progressively with fuel flow increase until the minimum propeller-governed r.p.m. is reached.

Further advance of the pilot's throttle lever causes an increase in the throttle valve opening and fuel flow without selecting any higher r.p.m. on the propeller control unit; the increase in T.G.T. and consequently of power is absorbed by progressive coarsening of the propeller blades at the same r.p.m.

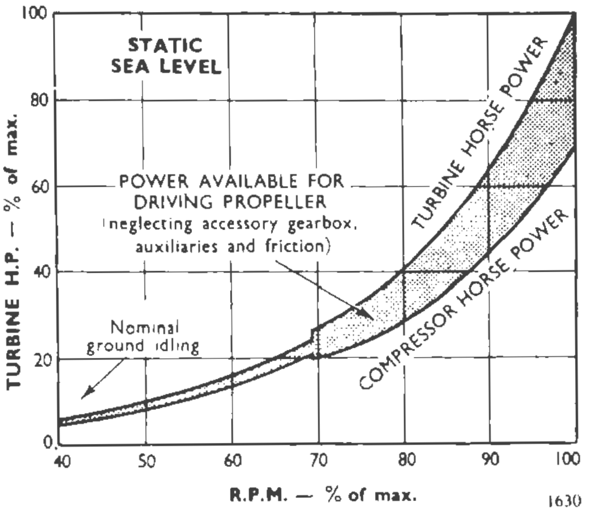


Fig. 7 Turbine power output

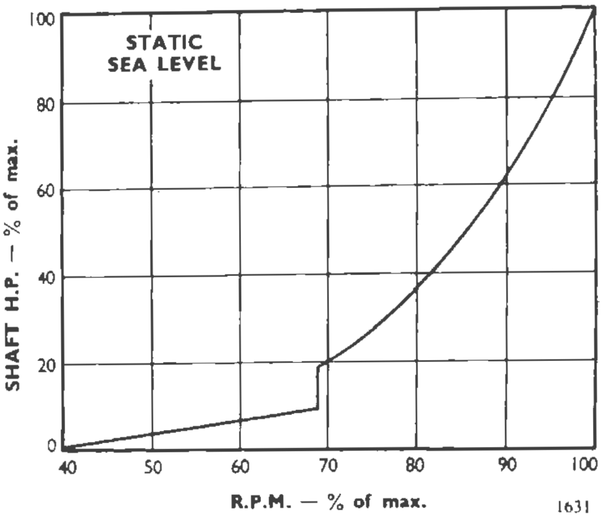


Fig. 8 Shaft h.p. variation with r.p.m.

This continues until a point is reached in the interconnection when further opening of the pilot's throttle lever selects progressively higher r.p.m. as well as increased fuel flow. The air flow, fuel flow, and T.G.T. all show corresponding increases in this, the flight operating range of the engine, until maximum power conditions are reached.

The pause at the minimum propeller-controlled r.p.m. gives rise to the characteristic 'step' in the performance curves for the Dart engine (fig. 7 to 10). At this point, when fuel is being added at constant r.p.m., the air mass flow actually decreases a little with the result that the power required by the compressor also decreases slightly (fig. 7).

Propeller drag

The zero pitch position permitted to the propeller when starting would offer excessive windmilling drag in the event of engine failure in flight. Latches or 'stops' are therefore provided in the propeller hub which prevent the blades from fining off excessively at take-off or in flight. These pitch latches are withdrawn on touch-down and permit the propeller to go into ground fine pitch; the resulting high windmilling drag then serves to reduce the landing run required by the aircraft.

Effect of ambient air temperature

When the atmospheric air temperature falls *below* the International Standard Atmosphere (I.S.A.) level, the efficiency rises and the power of the engine would also rise progressively were it not that the fuel flow is restricted to a certain maximum, i.e. the fuel flow appropriate to static I.S.A. sea-level conditions. Because of this fuel limitation, the turbine gas temperature cannot be maintained when the air density and consequently air mass flow increases with falling air temperature, and the power consequently falls also (fig. 11). Because of this progressive fall in T.G.T. as the atmospheric air temperature decreases, T.G.T. corrections are provided, as given under 'Adjustment/Test.'

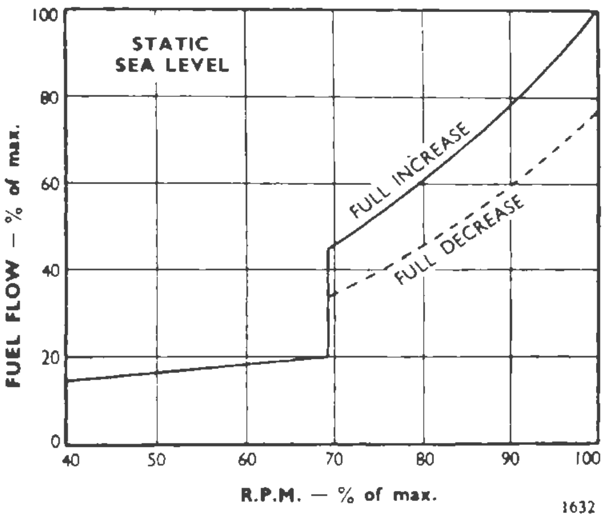


Fig. 9 Fuel flow variation with r.p.m.

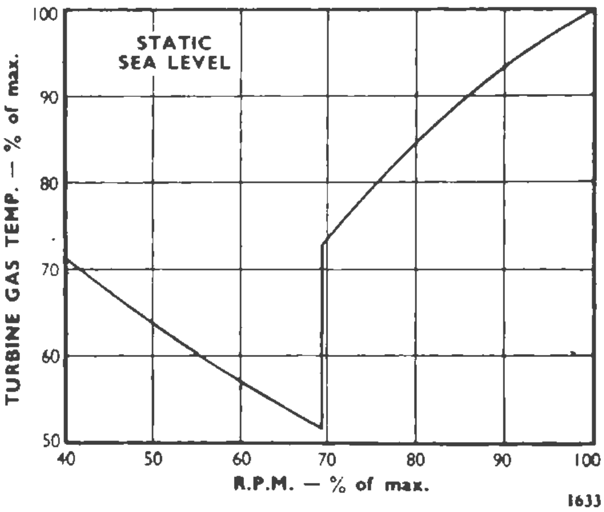


Fig. 10 Turbine gas temperature variation with r.p.m.

Where the air temperature rises *above* I.S.A., the T.G.T. rises at constant fuel flow because the air density and consequently air mass flow falls. To avoid exceeding the maximum permissible temperature the fuel flow must therefore be reduced.

This reduction in fuel flow without the alteration in r.p.m., which would follow from use of the pilot's throttle lever, is achieved by use of a 'trimmer' device, operated from the cockpit by an electric fuel datum control in conjunction with a position indicator.

With the fuel datum set at 'full increase' on the indicator gauge, there is no reduction in fuel flow. When the fuel datum is set at some lower figure, the fuel flow is proportionately reduced, or 'trimmed,' at all settings of the pilot's

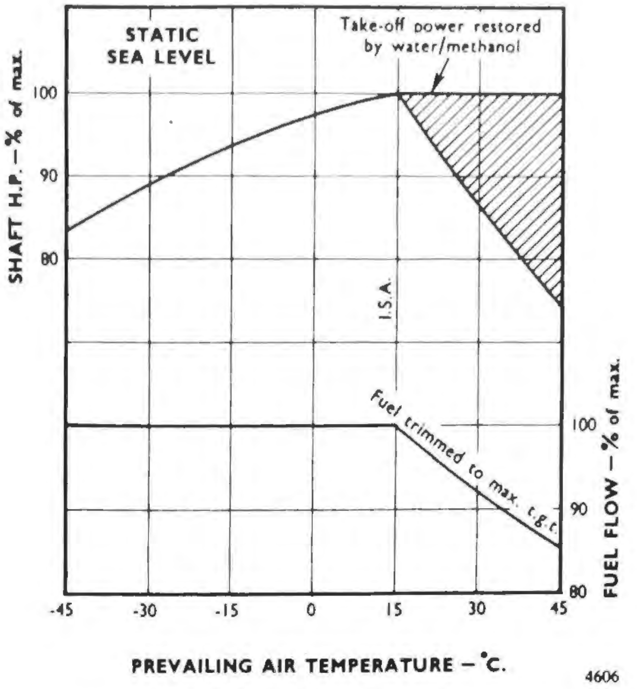


Fig. 11 Power and fuel flow variation with atmospheric temperature

throttle lever. At fuel datum 'full decrease' (indicator reading), fuel flow at any given throttle setting is reduced by more than 20 per cent from that at fuel datum 'full increase' (fig. 9).

With the fuel datum pre-set to a position appropriate to the ambient conditions, as given in tables under 'Adjustment/Test,' a satisfactory T.G.T. is automatically obtained on opening the pilot's throttle lever for take-off and initial climb. In flight, the fuel datum is adjusted to maintain a T.G.T. approaching the maximum permissible, for the reasons given previously.

The fall in air mass flow under hotter-than-I.S.A. conditions, referred to above, also means that less power is produced by the turbine. It is a characteristic of a compressor matched to a turbine that a reduction in mass flow is accompanied by a reduction in the pressure rise achieved by the compressor. It follows, therefore, that with the same turbine entry temperature there is on a 'hot' day less pressure and therefore temperature drop across the turbine, and this results in a further reduction in turbine power output. Whilst the power absorbed by the compressor also falls, this fall is less than the reduction in turbine power, and there is therefore a net decrease in propeller shaft horsepower (fig. 11).

For take-off purposes, however, the nominal power can be restored by injecting water/methanol. This mixture cools the air at the inlet to the compressor, restoring the density and the mass flow, and also provides the additional fuel required.

Specific fuel consumption

At static sea-level conditions, the efficiency and specific fuel consumption are best when the T.G.T. is at the maximum, i.e. at take-off conditions. At the lower r.p.m. used for cruising, the correspondingly lower T.G.T. is reflected in a small increase in specific fuel consumption (fig. 12).

Effect of altitude and forward speed

With increasing altitude, where the aircraft power requirements are less, engine power also falls with the drop in air density (fig. 13). However, the decreasing air intake temperature at increasing altitude results in an improved efficiency, as referred to previously; there is, therefore, an improvement in the specific fuel consumption up to the altitudes where propeller efficiency begins to fall away.

Forward speed raises the air intake pressure and so increases the air mass flow, in spite of the slight rise in intake temperature due to ram effect. Normally the fuel flow increases correspondingly to maintain the T.G.T.; forward speed therefore results in increased engine power.

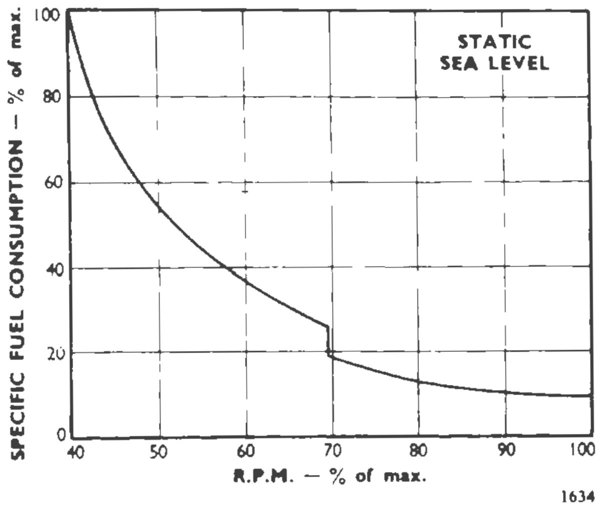


Fig. 12 Specific fuel consumption variation with r.p.m.

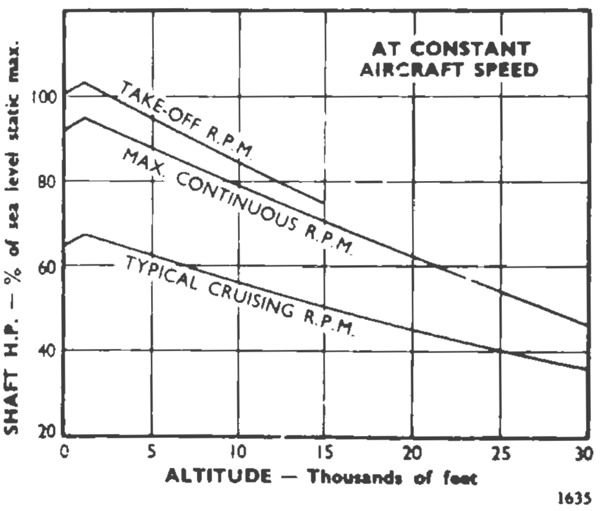


Fig. 13 Effect of altitude on engine power

At I.S.A. sea-level, however, where under static conditions the fuel flow is at its maximum, the increase in air flow due to forward speed is not accompanied by any increase in fuel flow. The resulting fall in T.G.T. limits the increase in engine power.

As the aircraft climbs from sea-level, air intake pressure and consequently air mass flow fall progressively. Fuel flow is maintained at maximum, however, until the height is reached at which ram air intake pressure falls below that of I.S.A. static sea-level.

Up to this point, therefore, falling airflow and constant fuel flow result in rising T.G.T. and hence engine power. Thereafter, as increasing altitude causes a further decrease in air intake pressure and mass flow, the fuel flow is automatically and progressively reduced to prevent the T.G.T. exceeding the limitation; power therefore falls off correspondingly, as shown in fig. 13.

TROUBLE SHOOTING

ENGINE

For all information concerning this section reference should be made to Chapter 71-0, page block 101.

SERVICING

ENGINE AND ENGINE BAY INSPECTION

1. Inspection/Check

A. Inspect the power plant

(1) Rotate the propeller in both directions; any unusual noise or stiffness encountered will indicate internal damage unless the symptom is diagnosed as being caused by a defective accessory or a temporary seal rub.

(2) If an accessory is suspected of being defective, remove the following units in sequence and check propeller rotation after each item is removed.

(a) Accessory gearbox (disconnect the drive coupling, at the engine end, to isolate).

(b) Fuel pump.

NOTE: (1) If the pump is noisy but the engine turns freely in each direction of rotation, the pump may be considered serviceable.

(2) If, in the normal direction of rotation, the engine progressively resists turning with, possibly, a tendency to 'spring back', do not apply further pressure until the cause is located and rectified (71-0,'Trouble Shooting'). Provided no other mechanical reason exists to account for this resistance, rotate the engine in the opposite direction of rotation; this should free the pump if 'pump stiction' has occurred. If a ground run is immediately carried out, the pump should continue to operate satisfactorily.

(3) When the ground run is completed, repeat (1) and (2); if 'pump stiction' persists, remove the fuel pump (73-2) and proceed with the action required when fuel contamination is suspected (refer to Chapter 89-8).

(4) After the engine and aircraft fuel systems have been completely drained, install a serviceable fuel pump (73-2), refuel the aircraft and bleed the complete fuel system (refer to 73-0 and to the aircraft maintenance manual).

(5) Set the fuel pump governor (73-2).

(6) Carry out an engine serviceability ground run.

Servicing - Engine and Engine Bay Inspection (cont.)

(c) Propeller control unit.

(d) Starter motor and clutch.

(3) Check for a temporary seal rub as described in 71-0, 'Trouble shooting, Rough running'.

(4) If, after the above checks have been made, the defect still persists, reject the engine.

(5) Remove the cowlings and carefully examine the engine for evidence of fuel leaks, oil leaks or gas blows; rectify as necessary.

(6) Clean the engine and cowlings. Engine and engine bay cleanliness facilitates visual inspection, since such minor defects as seepage of fuel, small oil leaks or gas blows are more readily detected and cured before they can develop into major failures.

(7) Check the following units for evidence of oil leaks.

(a) Low torque switch.

(b) Oil pressure transmitter and low oil pressure warning light switch.

(c) Feathering pump cut-out switch in the P.C.U. (if fitted).

NOTE: If external seepage of oil is evident at any of the above units, change the affected unit. Examine the connecting electrical leads for possible oil contamination and rectify where necessary.

(8) Check the engine components and mountings for security and freedom from cracking; if cracking is evident, refer to 71-0, 'Trouble Shooting, Rough running'. Examine pipes and electrical wiring for chafing, kinking or loose connections; rectify where necessary.

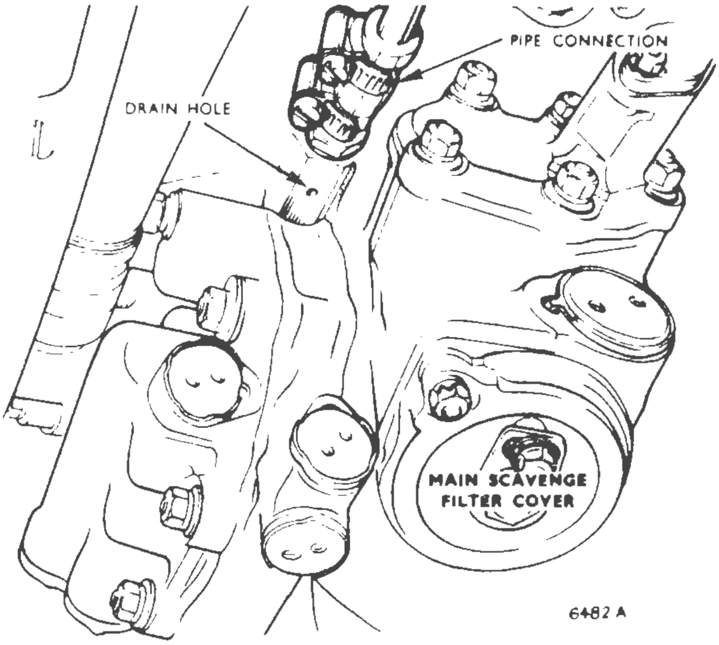
(9) Examine all bonding leads for correct fitting and ensure that the lead ends and clips are secure; leads which are too slack or too tight are liable to fail. On pre-Mod.907 (Service Bulletin DaMisc-11) engines check the bonding lead clips on all rigid magnesium alloy transfer tubes for security; if any clip is found to be loose, proceed as follows:

(a) Remove the clip, examine the transfer tube for signs of frettage and check the depth of wear using a suitable instrument.

(b) If frettage exceeds 0.010in. in depth, the transfer tube must be changed, but if it is less than this, the tube may be accepted for further service.

(c) If the tube is acceptable, reprotect the exposed metal surface by applying a solution of 10 per cent selenious acid in water until the metal surface turns a dark brown, then wash off surplus solution with water and dry off immediately. Refit the clip and spray the area with air drying varnish.

(10) At the recommended inspection periods, check that the ram pressure sensing pipe between the F.C.U. and the connection on the air intake casing is free from obstruction and water, as follows:



Ram pressure sensing pipe drain point
Fig. 301

(a) On pre-Mod.906 engines, disconnect the pipe clips from the water/methanol control unit and the front compressor casing; on Mod.906 engines, disconnect the pipe clips from the H.P. fuel pump mounting and the F.C.U.

(b) Loosen the hose clips securing the flexible hoses on the ends of the pipe to the connection on top of the F.C.U. and at the air intake casing; on Mod.906 engines, the pipe is connected to the base of the F.C.U. by a grooved connection and sealing ring.

(c) Disconnect and remove the pipe from the engine, then apply a compressed air supply to one end of the pipe to remove any obstruction or moisture.

(d) Apply a compressed air supply to the ram pressure connection on the air intake (Fig.301) and check that the drain hole is free from obstruction; clear the drain hole, if necessary, using a suitable piece of wire.

(e) On Mod.906 engines, check that the rattle pin is free to rotate and that the drain hole in the pipe is not excessively worn to an extent where the head of the rattle pin could pass through it. Where Mod.1188 has been embodied, however, the pin passes through a spring steel sleeve surrounding the pipe and drain hole, thus minimizing fretting of the drain hole.

(f) Before refitting the ram pressure sensing pipe on engine embodying Mod.906, fit a new sealing ring to the grooved connection on the end of the pipe and smear it with the lubricant specified in 89-1.

(g) Insert the pipe ends into the connections on the air intake and fuel control unit, tighten the hose clips and refit the pipe support clips.

B. Check the power plant after a shock-load or lightning strike

(1) General

(a) The standards following are intended as a guide for deciding whether or not an engine is fit for further service after the stresses imposed by a shock-load or the heavy electric discharge due to a lightning strike. The final decision will depend on the nature of the damage and the particular circumstances in which the shock-load was imposed.

(b) When an engine is considered serviceable after the appropriate checks detailed in (2),(3),(4) and (5), a serviceability ground run must be effected to check the engine handling and performance. When the engine is shut-down at the end of the ground run listen for any unusual noise which might indicate malalignment or distortion; refer to Chap.71-0, 'Trouble shooting, Rough running'.

(2) Check after a shock-load

(a) Engine rotating

(i) If the shock-load due to a propeller contacting the ground or a rigid object results in the engine being halted while running under load, or if the engine is damaged externally as by a 'wheels-up' landing, return the engine to an overhaul base for a complete strip inspection.

(ii) If a propeller is shock-loaded due to the propeller hitting the ground or a rigid object and has to be removed from an engine for repair, the shock-load may also have damaged the engine internally. In this case, return the engine to an overhaul base for a strip inspection based on engine condition.

(b) Engine rotating or stationary

(i) If, after a shock-load, the propeller does not need to be removed from an engine for repair, and the shock-load is known to have been slight then, provided the engine rotates freely and the engine oil filters are free from contamination after ground run, the engine can be considered serviceable.

(c) Engine stationary

(i) If, after a shock-load, the propeller has to be removed from an engine for repair a propeller shaft run-out check must be done to determine engine serviceability.

Servicing - Engine and Engine Bay Inspection (cont.)

(3) Check propeller shaft run-out (Fig.302)

CAUTION: WHEN REMOVING OR FITTING THE PROPELLER, AVOID SUBJECTING THE PROPELLER SHAFT TO ANY IMPACT AS THIS MAY RESULT IN AXIAL DISPLACEMENT OF THE SHAFT.

(a) Remove and examine the propeller in accordance with the instructions in the aircraft maintenance manual (Chap.61).

(b) If the propeller shaft is inadvertently displaced rearwards, effect the following procedure to return the shaft to the correct position.

CAUTION: ENSURE THAT A SPLIT-COLLET IS FITTED TO THE PROPELLER SHAFT.

(i) Dog the engine by fitting engine turning tool GU.15710 to the accessory drive.

(ii) Fit transportation cover, Mod.443, and end-cap to the propeller shaft, then torque tighten the end-cap to the loading specified in Chap.89-3 using a single hexagon socket and a suitable torque wrench.

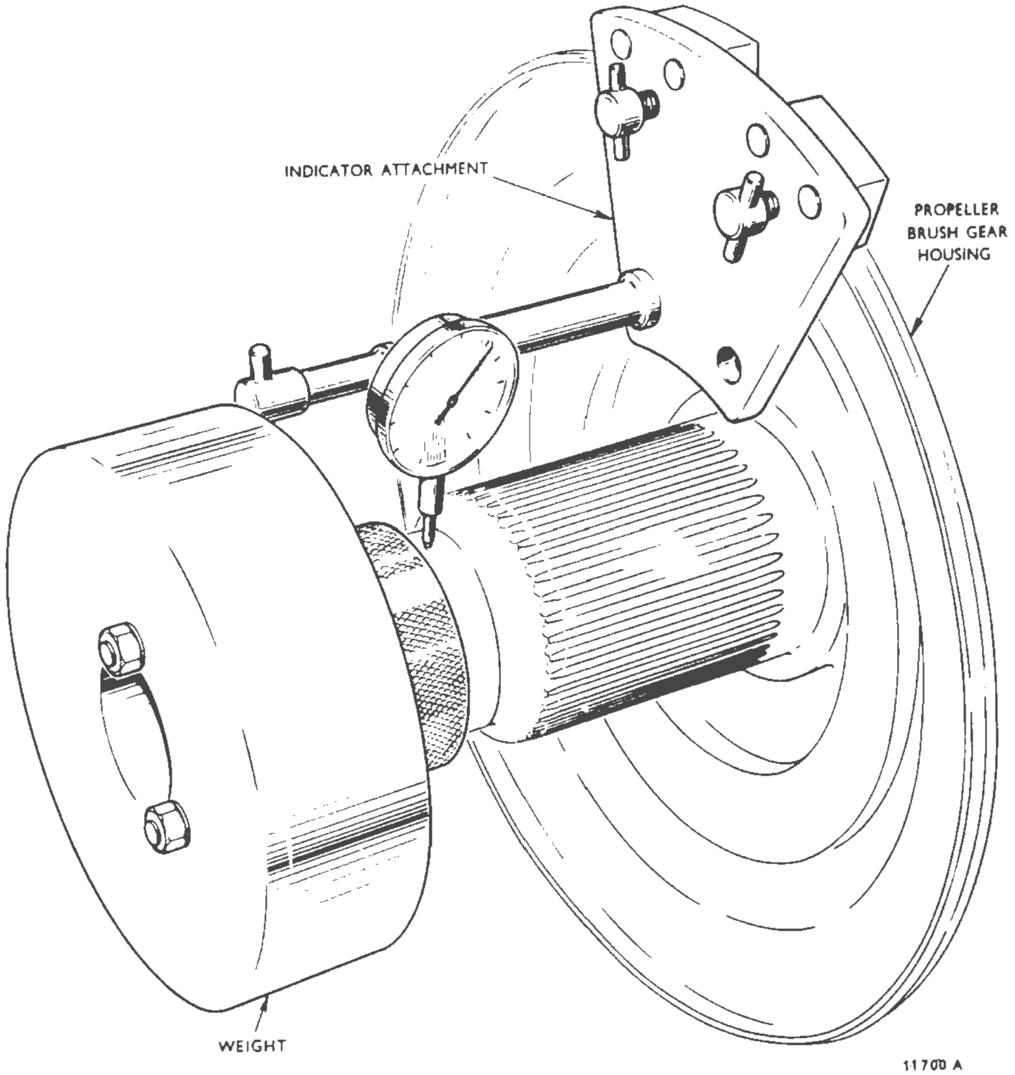
(iii) Remove the dogging tool and turn the propeller shaft to check for freedom of rotation.

(iv) Refit the dogging tool, slacken the end-cap, then remove the end-cap, transportation cover and dogging tool.

(c) Attach the pre-loading weight GU.11645 to the threaded portion of the propeller shaft and fit the indicator attachment tool GU.12233, together with dial test indicator Ref.No.1703073 or any other suitable dial test indicator, to the propeller brush gear housing as shown in Fig.302.

Servicing - Engine and Engine Bay Inspection (cont.)

(d) Rotate the propeller shaft, by turning the auxiliary gearbox drive using the engine turning tool GU.15710 and measure the propeller shaft run-out. If the run-out, i.e. variation between minimum and maximum readings, exceeds 0.002 in., remove the engine for examination at an overhaul base.



Propeller shaft run-out checking equipment
Fig.302

(4) Check after a lightning strike

(a) If the propeller has to be removed from the engine because of lightning damage, the engine must be returned to an overhaul base for strip inspection based on engine condition.

NOTE: Engine removal may be delayed for up to 100 engine hours from the time of the lightning strike, but only if the following checks are satisfactory.

(i) There must be no sign of external damage to the engine.

(ii) The engine oil filters must be checked initially and every 25 engine hours thereafter. The engine must be rejected if any contamination is found.

(b) If the propeller does not have to be removed because of lightning damage, the engine may be considered serviceable.

(5) Check after a heavy landing

(a) If an engine has been shock loaded due to an aircraft having been subjected to a heavy landing, and propeller impact has not occurred, effect the following check in addition to those specified in the aircraft maintenance schedule.

(i) Examine the areas of the compressor casing adjacent to the engine mounting feet, paying particular attention to the areas at the engine top mounting foot; reject the engine if there are any cracks which exceed the limits specified in Chap.72-3.

ADJUSTMENT/TEST

ENGINE

For all information concerning this section reference should be made to Chapter 71-0, page block 501.

POWER PLANT - CLEANING/PAINTING/PRESERVATION

1. General

Engines which are to be stored or transported require protection against the entry of foreign matter and against corrosion. Foreign matter is excluded by sealing off all apertures and corrosion can be prevented by inhibiting the engine placing V.P.I./C.H.C. paper into either the exhaust unit or the jet pipe, and packing the engine in a re-usable storage bag containing an appropriate amount of desiccant.

The maximum storage period for new and overhauled complete engines and accessories is 4 years. An overriding limit of 10 years commencing from the assembly date, however, applies to all engines under intermittent storage and service conditions for engines in service requiring an extension of this period reference should be made to Rolls-Royce Limited. If, for any reason, the fuel system is incomplete, the fuel units and the associated accessories remaining on the engine should be removed and stored in accordance with the instructions given in their respective sections.

Prior to storage, both installed and non-installed engines should be cleaned externally, any corrosion removed and the exposed metal re-protected, as described later in this section.

NOTE: It is important for jet pipe and exhaust unit blanks to be stencilled indicating the presence of V.P.I./C.H.C. paper in these units and to warn against the running of engines before the paper is removed.

The following tables give the recommended scheme of treatment for the protection and storage of the complete engine in differing climatic conditions. The materials required for the protection of engines during storage are listed under 'Servicing and storage materials' in 89-1.

The maximum periods permissible for storing installed engines are 3 months under tropical conditions and 6 months under temperate conditions. Engines which are to be stored for longer periods should be removed from the aircraft and packed in a storage bag.

During storage under outside conditions, installed engines should be inspected thoroughly and ground run every 14 days under tropical conditions and every 30 days under temperate conditions. It is recommended that each period of ground running is of 10 minutes duration, comprising 9 minutes at high ground idling and 1 minute at cruising.

The engine oil tank must be drained, see 72-8, before storage or shipment and the engine suitably placarded to indicate that the oil tank has been drained.

NOTE: Stored units should be maintained to the required modification standard and reference should be made to 89-13 for their individual maximum storage periods.

Power plant - Cleaning/painting/preservation (cont.)

INSTALLED ENGINES

CONDITIONS		ANTICIPATED PERIODS	FIT COVERS AND BLANKS	INSERT V.P.I./C.H.C. PAPER	GROUND RUN ENGINE	INHIBIT FUEL SYSTEM	APPLY INHIBITING FLUID TO PROPELLER SHAFT AND EXTERNAL DRIVES	GREASE CONTROLS	LANOLIN SPRAY ENGINE FORWARD OF BULKHEAD	REMOVE AND BAG ENGINE
OUTSIDE	Temperate and dry tropical	1 to 7 days	*							
		7 to 30 days	*	*						
		30 days to 6 months	*	*	*		*	*		
		over 6 months	*	*		*	*	*		*
	Humid tropical (above 80% humidity)	1 to 3 days	*							
		3 to 14 days	*	*						
		14 days to 3 months	*	*	*		*	*		
		over 3 months	*	*		*	*	*		*
INSIDE	Heated hangar and dry tropical	1 to 7 days	*							
		7 to 30 days	*							
		30 days to 6 months	*	*		*	*	*		
		over 6 months	*	*		*	*	*		*
	Unheated hangar temperate	1 to 7 days	*							
		7 to 30 days	*	*						
		30 days to 6 months	*	*		*	*	*	*	
		over 6 months	*	*		*	*	*		*
	Humid tropical (above 80% humidity	1 to 3 days	*							
		3 to 14 days	*	*						
		14 days to 3 months	*	*		*	*	*	*	
		over 3 moths	*	*		*	*	*		*

Power plant - Cleaning/painting/preservation (cont.)

UNINSTALLED
ENGINES

CONDITIONS		ANTICIPATED PERIODS	FIT COVERS AND BLANKS	INSERT V.P.I./C.H.C. PAPER	INHIBIT FUEL SYSTEM	APPLY INHIBITING FLUID TO PROPELLER SHAFT AND EXTERNAL DRIVES	GREASE CONTROLS	LANOLIN SPRAY ENGINE FORWARD OF BULKHEAD	BAG ENGINE
INSIDE	Heated hangar and dry tropical	1 to 7 days	*						
		7 to 30 days	*						
		30 days to 6 months	*	*	*	*	*		
		over 6 months	*	*	*	*	*		*
	Unheated hangar temperate	1 to 7 days	*						
		7 to 30 days	*	*					
		30 days to 6 months	*	*	*	*	*	*	
		over 6 months	*	*	*	*	*		*
	Humid tropical (above 80% humidity)	1 to 3 days	*						
		3 to 14 days	*	*					
		14 days to 3 months	*	*	*	*	*	*	
		over 3 months	*	*	*	*	*		*

NOTE: The above are the minimum requirements for engine storage and it is recommended that where possible, engines are stored in the bagged condition even when the duration of storage is less than 6 months. The application of lanolin spray to area forward of bulkhead, however, is unnecessary if the engine is stored in the bagged condition.

Power plant - Cleaning/painting/preservation (cont.)

If an engine is out of service for 1 year or longer in a temperate or dry tropical climate or for 6 months or longer in a humid tropical climate, the fuel burner shroud nuts may have to be inspected; refer to S.B.Da73-68.

Power plant - Cleaning/painting/preservation (cont.)

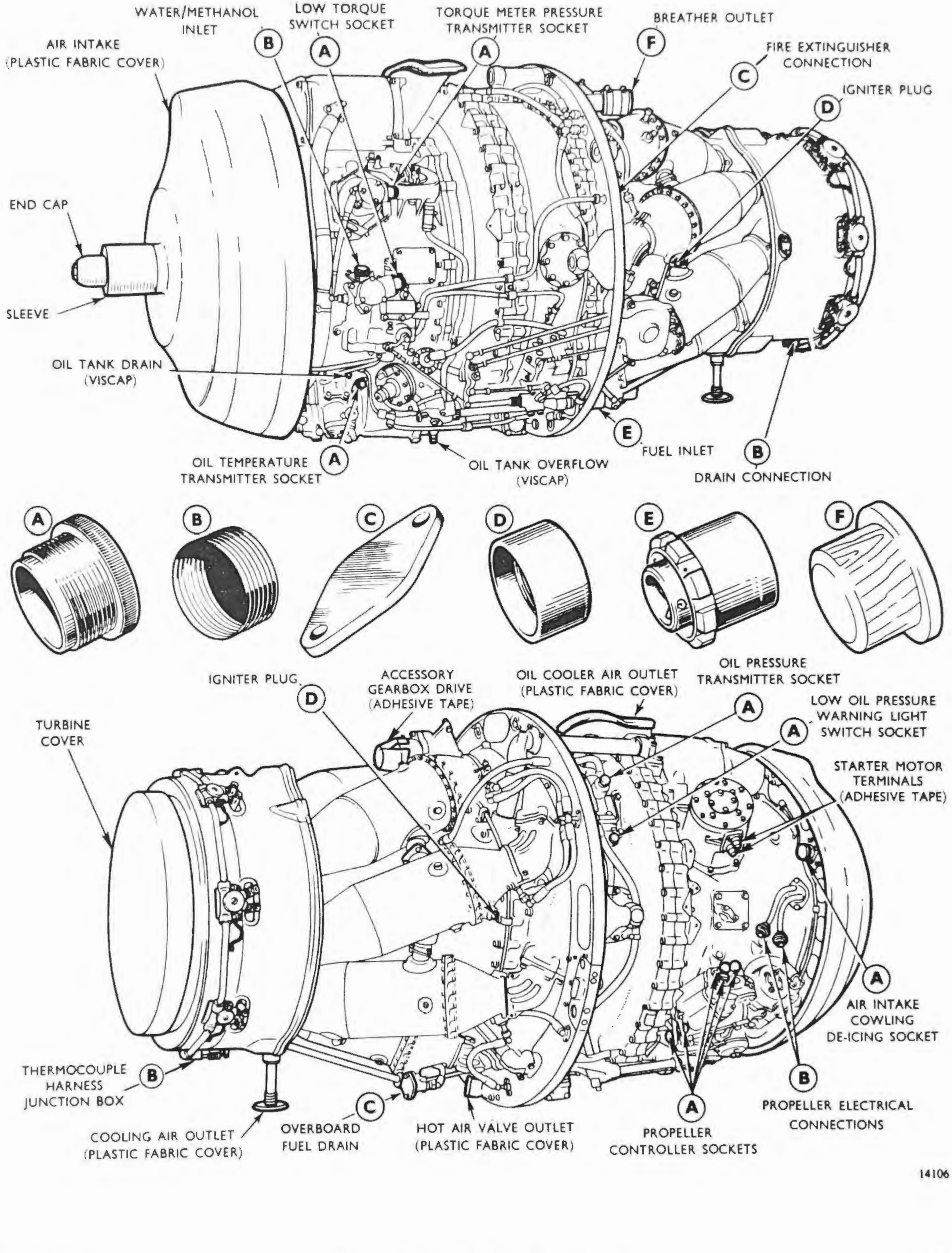

WATER/METHANOL INLET
LOW TORQUE SWITCH SOCKET
TORQUE METER PRESSURE TRANSMITTER SOCKET
BREATHER OUTLET
AIR INTAKE (PLASTIC FABRIC COVER)
B
A
A
F
FIRE EXTINGUISHER CONNECTION
C
IGNITER PLUG
D
END CAP
SLEEVE
OIL TANK DRAIN (VISCAP)
E
FUEL INLET
B
OIL TEMPERATURE TRANSMITTER SOCKET
A
OIL TANK OVERFLOW (VISCAP)
DRAIN CONNECTION
A
B
C
D
E
F
IGNITER PLUG
D
ACCESSORY GEARBOX DRIVE (ADHESIVE TAPE)
OIL COOLER AIR OUTLET (PLASTIC FABRIC COVER)
OIL PRESSURE TRANSMITTER SOCKET
A
LOW OIL PRESSURE WARNING LIGHT SWITCH SOCKET
A
TURBINE COVER
STARTER MOTOR TERMINALS (ADHESIVE TAPE)
A
AIR INTAKE COWLING DE-ICING SOCKET
THERMOCOUPLE HARNESS JUNCTION BOX
B
B
C
A
COOLING AIR OUTLET (PLASTIC FABRIC COVER)
OVERBOARD FUEL DRAIN
HOT AIR VALVE OUTLET (PLASTIC FABRIC COVER)
PROPELLER CONTROLLER SOCKETS
PROPELLER ELECTRICAL CONNECTIONS
14106

Fig.701 Blanking points

Power plant - Cleaning/painting/preservation (cont.)

2. Engine protection

A. Observe the following precautions against corrosion

(1) Clean the engine externally, using a brush and white spirit, taking care that the cleaning agent does not enter the air intake or any other aperture on the engine.

(2) Fit approved blanks and covers to all engine apertures (fig.701) to exclude moisture and foreign matter. Use adhesive tape where blanks are not provided.

(3) Inspect closely all enamelled castings; if the enamel is chipped, examine the exposed metal for corrosion.

(4) Remove completely any corrosion and re-protect the exposed metal as described later.

(5) Spray the inside and outside of the propeller shaft and the accessory gearbox drive shaft coupling with the inhibiting fluid specified in 89-1. Suitable spray equipment is illustrated in fig.702.

(6) Coat all control rod end fittings with the grease specified in 89-1.

CAUTION: FOR ENGINES WHICH ARE INSTALLED IN AIRCRAFT NOT IN SERVICE, THE RECOMMENDED METHOD OF AVOIDING CORROSION IS TO CARRY OUT GROUND RUNS AND TO INSPECT AT REGULAR INTERVALS IN ACCORDANCE WITH THE TABLE GIVEN PREVIOUSLY. FOR AN UNINSTALLED ENGINE, ENSURE THAT STORAGE CONDITIONS COMPLY WITH THE FOREGOING TABLE.

B. Re-protect enamelled castings

NOTE: With the exception of the compressor interstage and rear casings, connecting elbows and expansion chambers which are aluminium, and the nozzle box which is steel, all the main casings are magnesium.

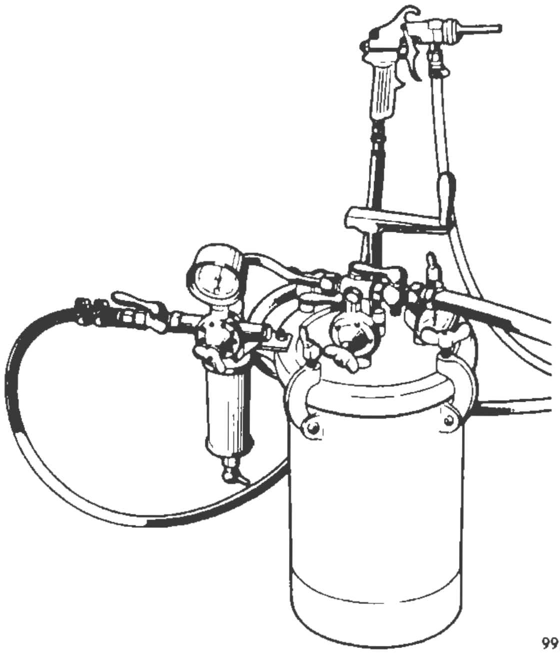
(1) Remove any corrosion from areas where the enamel has been chipped, first by scraping and then by rubbing with fine emery cloth.

(2) Treat all exposed metal on aluminium castings.

(a) Apply a coat of primer as specified in 89-1.

(b) Leave for 15 minutes to allow the primer to dry.

(c) Apply a coat of enamel as specified in 89-1.



Inhibiting spray equipment
Fig.702

(3) Treat all exposed metal on magnesium castings.

- (a) Apply a 10 per cent solution of selenious acid in water to the exposed metal unti a dark brown film is formed.
- (b) Wash off any surplus solution with water.
- (c) Dry the area immediately.
- (d) Reprotect the exposed metal, using primer and enamel as described above for aluminium castings.

3. Fuel system protection

A. General

The recommended method of protecting the fuel system is by draining the system of fuel and filling it with inhibiting oil (see 89-1) under pressure from a motor-driven rig.

Power plant - Cleaning/painting/preservation (cont.)

If a motor-driven rig is not available, a gravity feed rig may be used, requiring motoring over of the engine during inhibiting

Scrupulous cleanliness of both oil and equipment is essential.

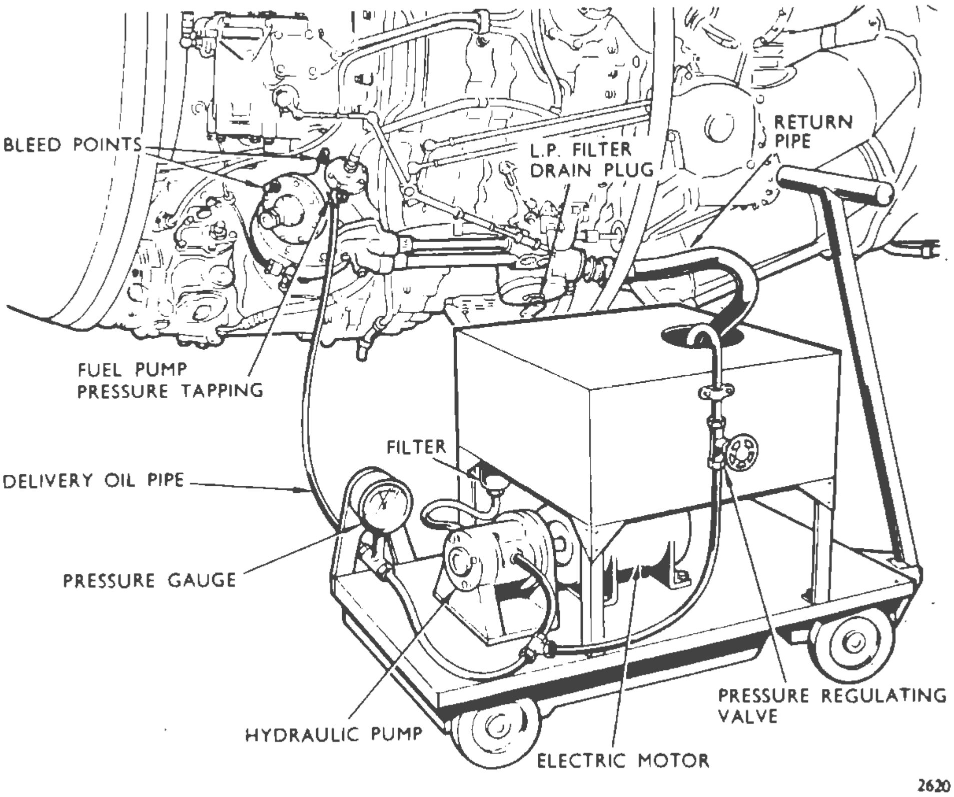
NOTE: Results from the use of the gravity feed rig are liable to be less effective; use only when a motor-driven rig is unobtainable.

When the H.P. cock and throttle are opened fully with the engine stopped, the automatic propeller coarsening circuit is completed if the aircraft electric services are switched on. Prevent this by tripping the appropriate circuit breaker or by avoiding opening the throttle beyond the half-way position.

B. Inhibiting equipment

(1) Motor-driven rig

A typical motor-driven rig is shown in fig.703.



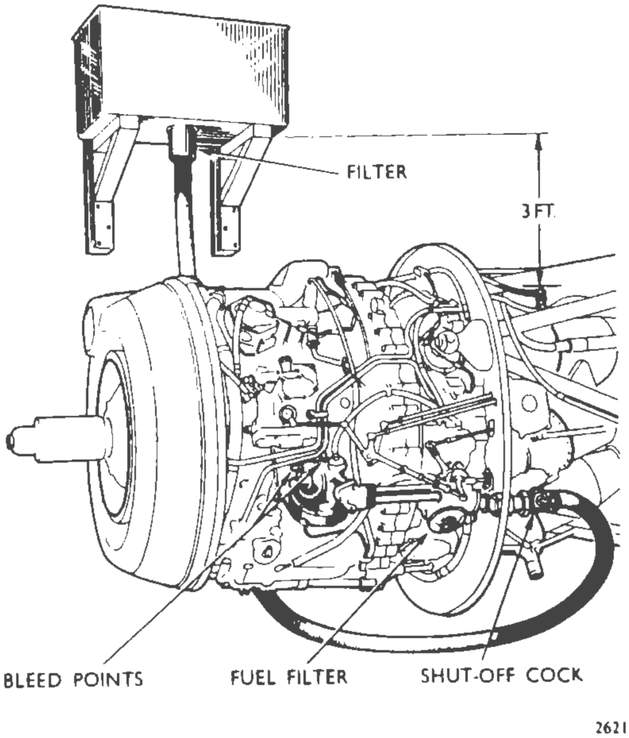
Typical motor-driven inhibiting rig
Fig.703

The rig consists basically of an oil tank, an electrically driven hydraulic pump, a delivery pipe incorporating a release valve, a pressure gauge reading up to 500 p.s.i., and a return pipe which must be free of all restrictions. The capacity of the oil tank is required to be 5 Imperial (6 U.S.) gallons, the bore of the delivery pipe 1/4in. minimum, and the pump must be capable of delivering 2 gallons per minute at a pressure of 300 p.s.i. Filtration of the inhibiting fluid is provided by a 10 micron filter at the tank outlet.

(2) Gravity feed rig

The gravity feed rig (fig.704) comprises a tank of 5 Imperial (6 U.S.) gallons capacity, mounted to give a minimum head of 3 ft. above the highest point in the fuel system, and a pipe of 1in. bore fitted with a shut-off cock. Filtration of the inhibiting fluid is provided by a 100-mesh (British Standard) filter placed in the tank outlet.

The connecting pipe from the tank to the main fuel inlet on the engine must be free from sharp bends and must have its shut-off cock fitted as near as possible to the engine connection.



Gravity feed inhibiting rig
Fig.704

Power plant - Cleaning/painting/preservation (cont.)

When the engine is installed in an aircraft, the aircraft starter system can be used to turn the engine during inhibiting. The engine must be allowed to come to rest between motoring cycles, as operation of the starter motor while the engine is still turning will result in damage to the starter engaging mechanism.

If the aircraft starter system is inoperative, a turning rig must be employed. A rig can be easily constructed from standard equipment, using 30-volt batteries and an aircraft starter panel complete with switches and leads to the starter motor.

C. Inhibit the fuel system (using a motor-driven rig)

(1) Set the aircraft switches and cocks as follows:

Starter master switch	SAFE
Igniters	OFF
H.P. and L.P. fuel cocks	CLOSED
Throttle valve	CLOSED

(2) Remove the domed nuts from the bleed points on the fuel pump and attach the bleed tools (73-0, 'Maintenance practices').

(3) Loosen the L.P. filter drain plug and drain the fuel, depressing the bleed tool plungers to assist drainage.

CAUTION: IF THE DRAINED FUEL SUGGESTS CONTAMINATION, REMOVE AND RENEW THE FILTER ELEMENT (73-4 'MAINTENANCE PRACTICES'), UNLESS THE ENGINE IS BEING RETURNED FOR OVERHAUL.

(4) Tighten the drain plug.

(5) Disconnect the fuel inlet pipe to the filter and blank off the pipe; connect the large bore return pipe to the filter inlet, directing its open end into the oil tank. This pipe must be free of all restrictions.

(6) Remove the blanking plug from the pressure tapping on the fuel pump and connect the rig delivery pipe.

(7) Check that the inhibiting rig tank contains at least 5 Imperial (6 U.S.) gallons of oil.

(8) Start the rig pump and allow the fuel system to fill with oil at a pressure of 50 p.s.i. until oil flows from the large return pipe.

CAUTION: THE INITIAL DISCHARGE OF OIL (APPROXIMATELY 1 GALLON) WILL BE CONTAMINATED WITH FUEL AND SHOULD THEREFORE BE RUN TO WASTE.

(9) Direct the open end of the return pipe into the oil tank and depress the bleed tool plungers until oil is emitted in a steady stream free from air bubbles; release the plungers.

(10) Slowly increase the pressure to 300 p.s.i. and retain for 5 minutes, turning the engine by hand and operating the throttle and H.P. cock two or three times during the last 1/2 minute.

CAUTION: DO NOT OPEN THE THROTTLE BEYOND THE HALF-WAY POSITION UNLESS THE AUTO-FEATHERING CIRCUIT IS BROKEN.

(11) Close the H.P. cock and throttle.

(12) Stop the rig, remove the bleed tools, disconnect the delivery and return pipes, and blank off each engine connection immediately.

D. Inhibit the fuel system (using a gravity feed rig)

(1) Set the aircraft switches and cocks as follows:

Starter master switch	SAFE
Igniter	OFF
H.P. and L.P. fuel cocks	CLOSED
Throttle valve	CLOSED

(2) Remove the domed nuts from the bleed points on the fuel pump and fit the bleed tools (73-0, 'Maintenance practices').

(3) Loosen the L.P. filter drain plug and drain the fuel, depressing the bleed tool plungers to assist drainage.

CAUTION: IF THE DRAINED FUEL SUGGESTS CONTAMINATION, REMOVE AND RENEW THE FILTER ELEMENT (73-4, 'MAINTENANCE PRACTICES'), UNLESS THE ENGINE IS BEING RETURNED FOR OVERHAUL.

(4) Tighten the drain plug.

(5) Disconnect the fuel inlet pipe to the filter and blank off the pipe. Connect the inhibiting rig delivery pipe. This pipe must be free of all restrictions.

(6) Check that the inhibiting tank contains at least 5 Imperial (6 U.S.) gallons of oil. Turn on the inhibiting rig oil supply.

(7) Depress the bleed tool plungers until oil is emitted in a steady stream free from air bubbles; release the plungers.

Power plant - Cleaning/painting/preservation (cont.)

(8) Check that the engine tank contains sufficient oil (see 72-8), then with the starter master switch set to BLOW OUT, carry out a motoring cycle; midway through the cycle, open the H.P. cock and throttle to flush the burner manifold and burners.

CAUTION: DO NOT OPEN THE THROTTLE BEYOND THE HALF-WAY POSITION UNLESS THE AUTO-FEATHERING CIRCUIT IS BROKEN.

(9) When the engine has stopped turning, close the H.P. cock, disconnect the inhibiting rig pipe and blank off the fuel feed connection immediately.

(10) Remove the bleed tools from the fuel pump and refit the domed nuts.

4. Packing the engine

To protect the engine or power-plant against dust and atmospheric corrosion during transit and storage, a re-usable bag with a hermetic seal is required.

A Plastoglass bag Part No.CP.3093/1, made from glass cloth P.V.C. laminate, or Plastolene bag Part No.CP.3093/3, made from terylene/P.V.C. laminate, may be obtained from Rolls-Royce Limited.

NOTE: The Plastolene bag has superseded the Plastoglass bag.

Before an engine is enclosed in it, protect the engine and include a humidity indicator and desiccant in the bag before sealing it. Refer to the table on the bag for the amount of desiccant to be used. The amount varies with length and condition of storage and the type of bag used. The Plastolene bag requires less desiccant than the Plastoglass type.

The recommended humidity indicator is a chemically treated card which changes colour in the presence of moisture. It is enclosed in a small paper envelope which shows the SAFE (blue) and UNSAFE (pink) colours and is placed in the pocket behind the inspection window provided. Until the indicator changes to an UNSAFE colour, the contents of the package are safe from corrosion.

A. Pack the engine in a re-usable bag (Plastoglass or Plastolene type)

(1) Prepare the engine

(a) Inhibit the fuel system and spray the propeller shaft and accessory gearbox drive shaft internally and externally, as described earlier.

(b) Ensure that the engine is clean externally. Turn back any projecting split pins and lock wires which may foul the bag.

(c) Fit the usual transportation blanks to prevent the ingress of foreign matter and to guard against the emission of oil or kerosine.

CAUTION: THE BAG IS RESISTANT TO THE EFFECTS OF SYNTHETIC OILS, BUT CAN BE ADVERSELY AFFECTED BY PROLONGED CONTACT WITH SUCH OILS.

(2) Fit re-usable bag to engine stand

(a) Stand Part No. CP.1882 and CP.2103 - remove the top support and two support brackets as in 6.C.(3). Standard Part No CP.4005/1 - remove the top support and two engine supports as in 6.E.(4).

(b) Open out the bag and drape it over the stand with the inspection window just forward of the left-hand base frame upright.

(c) Align the bolt holes in the two specially strengthened areas of the bag with those in the base frame uprights and replace the engine supports, sandwiching the specially strengthened areas of the bag but do not tighten the bolts (on CP.4005/1). Mount the engine on the stand CP.1882, CP.2103 see 6.C.(3) and CP.4005/1 see 6.E.(4).

(3) Seal the bag

(a) Cover the engine fore and aft with two 6 ft. x 3 ft. sheets of greaseproof paper or P.V.C. film.

(b) Place the humidity indicator in the pocket behind the inspection window.

(c) Pack the required amount of desiccant into bandoliers according to the anticipated period and conditions of storage, see table on the bag.

NOTE: Each bandolier contains 7 x 1 lb. bags of desiccant. An abbreviated instruction and desiccant chart is enclosed in the bag behind a plastic window adjacent to the data plate and humidity indicator window.

(d) Carefully draw the top edge of the bag over the engine and close it by pulling the slider slowly along the length of the interlocking closure; keep the slider as near parallel as possible to the line of closure.

CAUTION: EXPOSURE TO ATMOSPHERE FOR MORE THAN 10 MINUTES WILL RENDER THE SILICA GEL INEFFECTIVE. THIS DESICCANT MUST REMAIN IN THE SEALED CONTAINER UNTIL REQUIRED.

(e) Examine the bag in position for punctures and tears which may have occurred during fitting; repair as required, see 4.C. and D.

B. Inspect the stored engine in the re-usable bag.

(1) Check that the humidity indicator shows safe, i.e. its colour is blue, at the following intervals:

(a) 24 hours after receipt or desiccation of the bag.

(b) One week after receipt or desiccation.

Power plant - Cleaning/painting/preservation (cont.)

(c) Thereafter each month throughout storage period.

NOTE: For the inspection of bag after transportation by air, see under 5.B.

(2) When a check of the humidity indicator reveals an UNSAFE reading, i.e. its colour has changed from blue to lilac or pink:

(a) Inspect the engine for signs of corrosion and, if necessary, re-protect as described previously

(b) Inspect the bag for damage and repair as required (see 4.C. and D.).

(c) Renew the desiccant in the bag before re-sealing.

CAUTION: IF THERE IS ANY REASON TO SUSPECT THE STATE OF PRESERVATION OF THE ENGINE, OPEN THE BAG AND VISUALLY EXAMINE FOR SIGNS OF CORROSION. SIMILARLY, IF THE BAG HAS BEEN OPENED FOR ANY REASON, E.G. TO WORK ON THE ENGINE, RENEW THE DESICCANT BEFORE RE-SEALING.

C. Inspect the re-usable bag (Plastoglass or Plastolene type)

(1) The maximum practicable size of repair patch is 24in. by 12in. and the patch must be at least 3 in. larger than the puncture and/or tear.

(2) The number of punctures and/or tears which may be repaired is subject to (1) above.

(3) Punctures which may be repaired do not generally exceed $^{1}/2$in. diameter.

(4) The size of tears which may be repaired is subject to (1) above.

(5) Tears which exceed the limits (4) may be repaired by the manufacturer if the overall condition of the bag is otherwise satisfactory.

(6) Damage to the bag closure must be repaired by the manufacturer.

(7) Ensure that the bag pressure relief valve (if fitted) is free to function correctly.

(8) Remove all P.V.C. adhesive tape, which has been used for temporary repair of the bag, to facilitate inspection.

D. Repair the re-usable bag (Plastoglass or Plastolene type)

(1) Cut a patch from the repair material at least 3in. larger than the puncture or tear in the bag.

(2) Clean the outside area of the bag to be repaired with detergent in the vicinity of the damage; dry, and then wipe this area and one side of the patch with a cloth slightly moistened with petrol or trichloroethane.

(3) Apply a coat of adhesive to the cleaned surface of the patch and its mating face on the bag; when dry stick the patch to the bag and press together to secure.

(4) Dust around the patch, inside and outside, with french chalk.

Where it is not possible to carry out the above procedure, as a temporary measure the following is permissible:

(a) Clean both inside and outside the damaged areas of the bag with detergent and dry thoroughly.

(b) Build up strips of P.V.C. self-adhesive tape over the puncture or tear, both inside and outside the bag.

5. Transportation

A. Surface transport

(1) Before transit by road, rail or sea:

(a) Ensure that a split collet is fitted to the propeller shaft, then fit the transportation cover and end cap and torque tighten as described in 89-3.

(b) Refer to '1. General', '2. Engine protection', '3. Fuel system protection' and '4. Packing the engine'.

(c) Enclose the engine in a re-usable bag and pack in wooden packing case, Part No.CP.1910.

B. Air transport or road transport with careful handling assured

(1) Carry out A.(1) above but a packing case need not be used.

CAUTION: WHENEVER AN ENGINE OR POWER PLANT IS TO BE FREIGHTED WITHOUT THE PROTECTION OF A PACKING CASE CARE SHOULD BE TAKEN TO ENSURE THAT SUCH ITEMS AS THE NOSE COWL, EXHAUST UNIT, L.T. HARNESS ETC., ARE ADEQUATELY PROTECTED AGAINST THE POSSIBILITY OF DAMAGE DURING TRANSIT.

NOTE: A pressure relief valve is fitted to prevent the bag 'ballooning' at altitude.

(2) Inspect as specified in 4.B. above if the engine is to be stored on arrival.

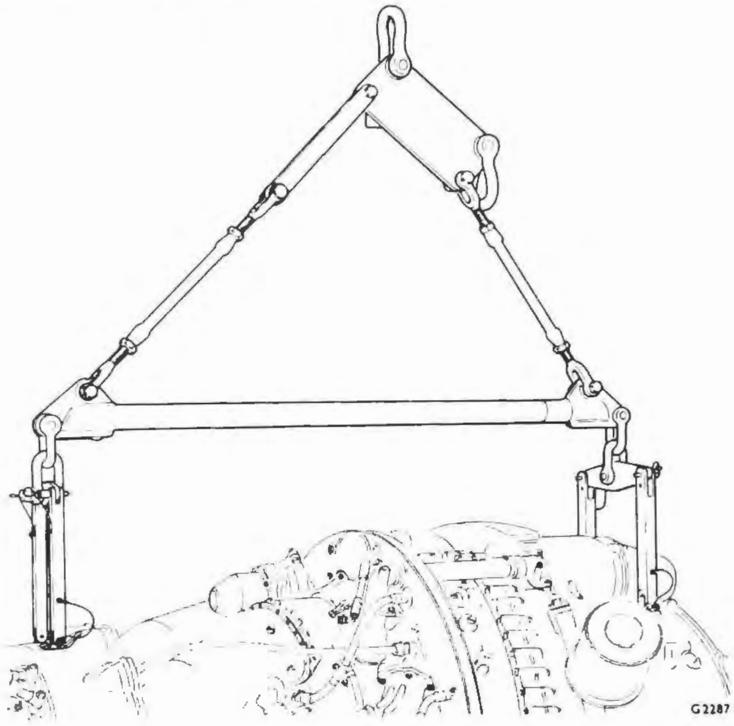
6. Handling equipment

A. Engine sling Part No. GZ.02086/1

(1) The engine sling (Fig.705) has alternative lifting points to enable the engine/power plant to be slung with or without the propeller, and a turnbuckle (stretcher) in each leg of the sling to allow the engine's attitude, when slung, to be adjusted if necessary.

NOTE: Engine sling, Part No. J.54595/1, may also be used on all Dart R-Da7 and earlier type engines. This is an earlier model of sling (J.54595) fitted with improved turnbuckles (stretchers), link and bolts (Mod. set GZ.40207).

CAUTION: **DO NOT USE AN ENGINE SLING TO LIFT MORE THAN THE ENGINE/POWER PLANT (WITH OR WITHOUT THE PROPELLER).**



Engine sling
Fig.705

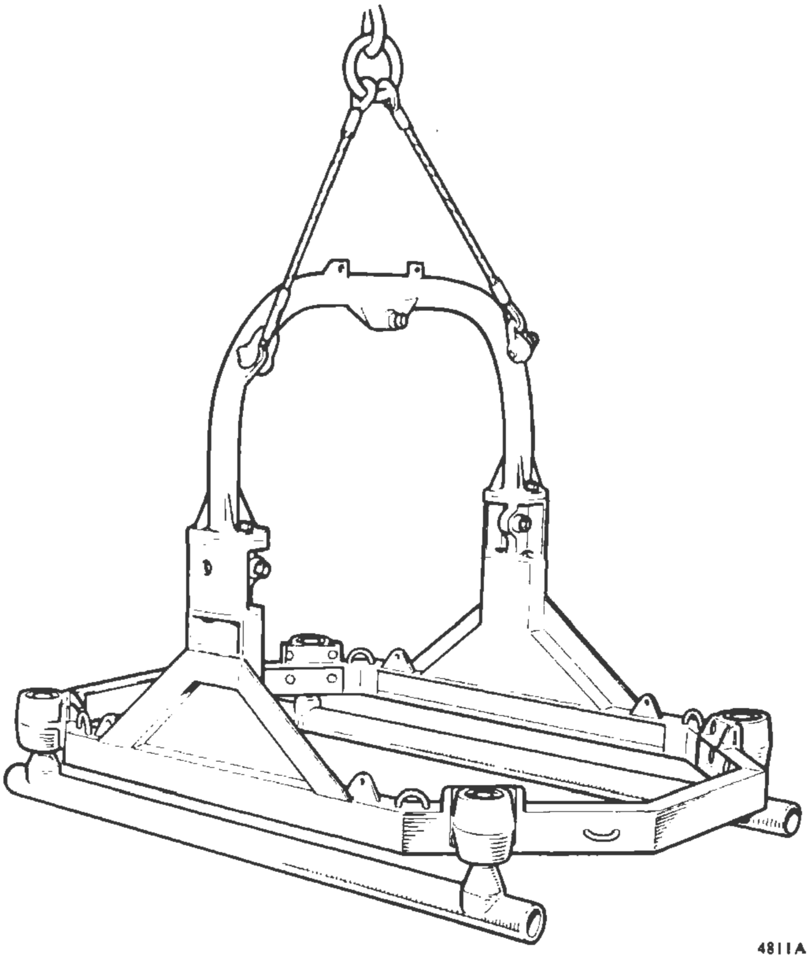
B. Engine and stand sling

(1) For lifting the engine and its stand together, use sling Part No. CP.2119; this attaches to the lifting eyes of the stand as shown in Fig.706 and 707.

C. Transportation stand Part No. CP.1882 and CP.2103

(1) The stand CP.1882(Fig.706)is suitable for transportation of the bare engine only.

(2) The stand CP.2103 is similar to stand CP.1882 with modification to provide an adjustable mounting between the stand, base frame and skids to enable engine and stand to be loaded through the Friendship aircraft loading door. A protection plate with rubber packing is fitted to the stand top support to protect the engine bulkhead.



Transportation stand and sling
Fig.706

(3) Fit the engine to stand Part No.CP.1882 or CP.2103.

(a) Remove the top support (with protection plate and rubber packing CP.2103) and the two support brackets from the stand.

(b) With the engine suspended by the approved sling, attach the support brackets to the side engine mounting feet but do not tighten the securing bolts.

(c) If the engine is to be packed in a re-usable transportation bag see 4.A. 'Packing the engine'.

CAUTION: EXAMINE THE ENGINE MOUNTING SPHERICAL BUSHES FOR DAMAGE BEFORE FITTING, AND REMOVE ANY HIGH SPOTS NOTED TO AVOID SCORING THE ENGINE FEET; CLEAN AND LUBRICATE BUSHES AND BOLTS BEFORE ASSEMBLY. THE ENGINE TRANSPORTATION MOUNTING BOLTS AND BUSHES ARE NOT TO BE INTERCHANGED BETWEEN THE AIRCRAFT MOUNTING AND THE TRANSPORTATION STAND.

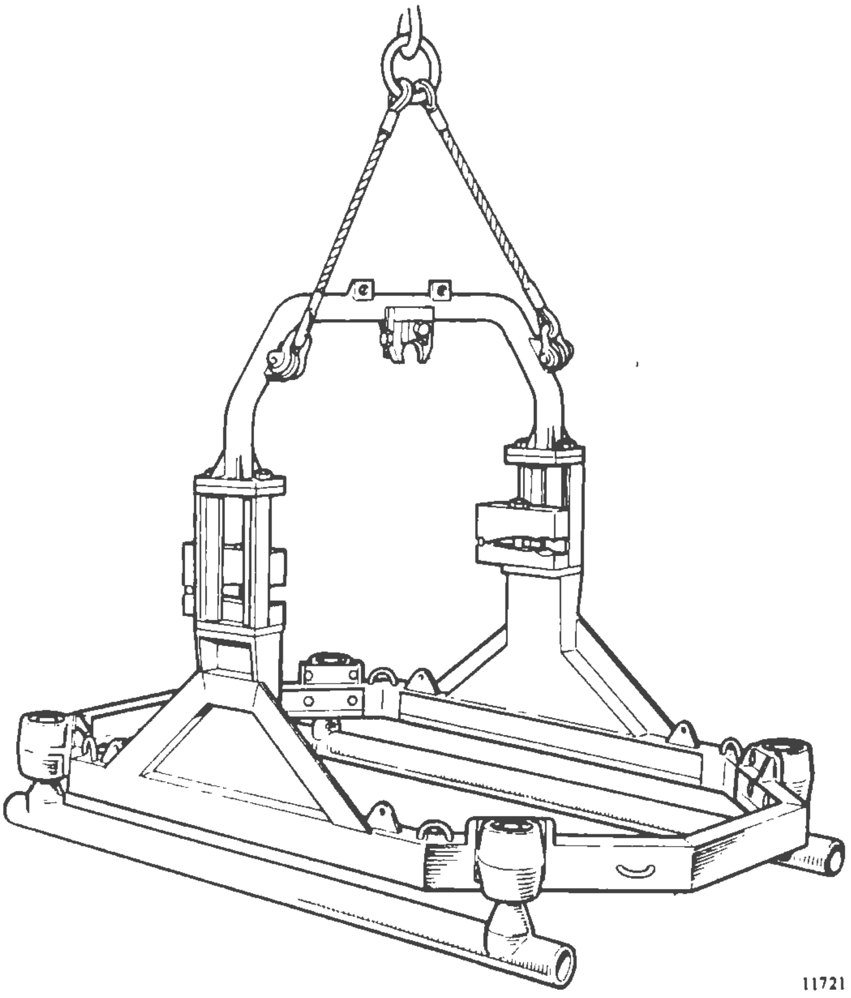
Power plant - Cleaning/painting/preservation (cont.)

(d) Feed the top support (with protection plate and rubber packing CP.2103) through and beneath the engine sling and position it on top of the support brackets, enter the bolts and nip them. Attach the top engine mounting foot to the top support and nip the securing bolt.

(e) Lower the engine gradually into position, locating the support brackets on the locating pins projecting from the base frame uprights. Bolt each bracket to the base frame (sandwiching the specially strengthened area of the re-usable bag, if fitted).

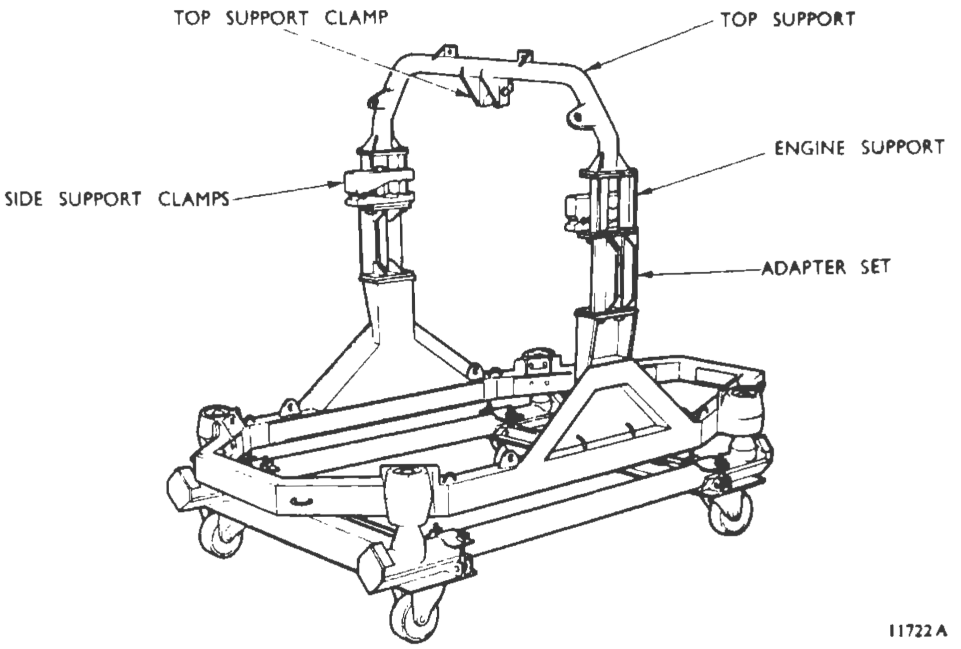
CAUTION: DO NOT PERMIT THE COOLING AIR OUTLET TO FOUL THE REAR CHANNEL OF THE BASE FRAME. KEEP MOVEMENT BETWEEN ENGINE AND STAND TO A MINIMUM. TO AVOID POSSIBLE DAMAGE TO THE ENGINE FEET BORES WHEN INSTALLING OR REMOVING AN ENGINE FROM A STAND, ADJUST THE LIFTING SLING SO THAT THE SECURING BOLTS CAN BE FITTED OR REMOVED BY HAND; USE A SPANNER ONLY FOR TH FINAL TIGHTENING OR INITIAL SLACKENING OF THE BOLTS.

(f) Tighten the bolts securing the top support to the support brackets.



Transportation stand and sling
Fig.707

Power plant - Cleaning/painting/preservation (cont.)



Mobile power plant build stand
Fig.708

(g) Tighten all three engine mounting securing bolts evenly and remove the sling.

(h) Wire lock the bolts securing the side brackets and the top support.

D. Transportation stand Part No.CP.4005/1

The stand fig.707, is suitable for storage and transport of the engine or power plant. Castor system Part No.CP.5622 with towing arm Part No.CP.5559 can be used for mechanical towing of the engine in the transportation stand at low speed over level ground.

E. Mobile power plant build stand Part No.CP.3700

The stand fig.708, can be used for power plant build, but movement is restricted to manual traction over smooth surfaces within the workshop.

The stand consists of the following parts:

(1) Transportation stand Part No.CP.4005/1.

(2) Two extension pieces and attachment bolts comprising adapter set Part No.CP.8949.

Power plant - Cleaning/painting/preservation (cont.)

(3) Castor system Part No.CP.2709.

CAUTION: IT IS ESSENTIAL THAT ANY ALTERNATIVE DESIGN OF STAND USED IS APPROVED BY ROLLS-ROYCE LTD., AS INCORRECT MOUNTING DURING TRANSIT CAN CAUSE DAMAGE TO THE ENGINE.

(4) Fit the engine to stand Part No.CP.4005/1 or CP.3700.

(a) Remove the top support from the stand, and remove from it the top support clamp.

(b) Remove the side support clamps from the engine supports.

(c) Loosen the bolts securing the engine supports to the base frame uprights (CP.4005/1) or adapter set CP.8949 if used for power plant build.

(d) If the engine is to be packed in a re-usable transportation bag see 4. 'Packing the engine'.

(e) Enter the engine from the rear of the stand, using the approved engine sling, and lower it so that the engine foot on each side locates in the spherical recess in the support bracket.

CAUTION: AVOID FOULING THE HEATER (IF FITTED) AGAINST THE REAR CHANNEL OF THE BASE FRAME. KEEP MOVEMENT BETWEEN THE ENGINE AND THE STAND TO A MINIMUM.

(f) Replace the side support clamps and nip the side engine mounting feet.

(g) Tighten the bolts securing the engine supports to the base frame uprights (CP.4005/1) or adapter set CP.8949 if used for power plant build.

(h) Feed the top support through and beneath the engine sling; enter but do not tighten the bolts securing it to the engine supports.

(i) Fit the top support clamp to the top engine mounting foot, square the clamp to the top support and nip both the bolt securing the foot and that securing the clamp to the top support.

(j) Tighten the bolts securing the top support to the engine supports.

(k) Torque tighten the side support clamps to the loading marked on the stand.

(l) Tighten the top support clamp on to the engine foot to the torque loading indicated; tighten the clamp on the top support and secure with the locknut.

(m) Wire lock and split pin the remaining bolts as required.

SAH3/1-Bry M-Da7-V

DESCRIPTION

AIR INTAKE

The air intake casing, illustrated in fig. 1 and 2, is one of the main structural components of the engine, and embodies an annular duct which directs air to the compressor.

To provide a smooth path for air entering the engine, a spinner extension piece is fitted to the reduction gear casing and forms a transition piece between the spinner and the inner wall of the intake duct.

A nose cowling, illustrated in fig. 3, is fitted to the front of the air intake and has an integral entry duct for airflow through the oil cooler. It carries insulated electrical de-icing elements, as described later in this section, and also the forward fire extinguishing ring.

The intake casing carries the centrally mounted reduction gear, an integral oil tank, the lower bevel housing, and is fitted with two of the engine lifting eyes.

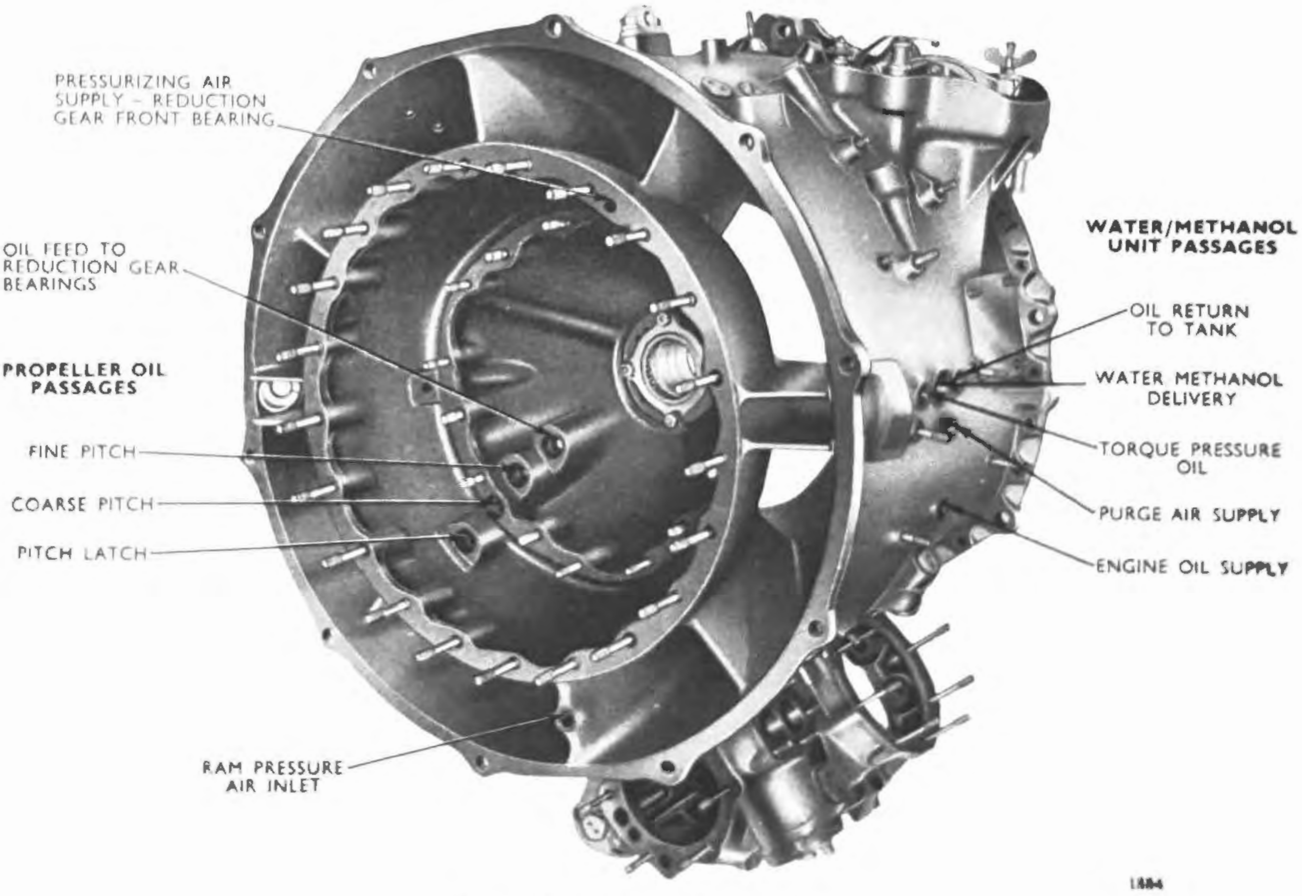


Fig. 1 Air intake casing — front view

The casing is designed also to accommodate a number of engine units. Provision is made in the casting for the necessary drives and supply passages, hollow support webs across the annular duct accommodating the drive from the starter motor to the main shaft, and that from the reduction gear to the lower bevel housing.

On the lower bevel housing are mounted externally the fuel pump and propeller controller unit; the oil pressure and scavenge pumps are positioned internally. The gear train to these units is described later in 72-4.

Cored and drilled passages in the air intake casting distribute oil for engine lubrication and propeller operation, pressurizing air to bearing seals, and water/methanol from the metering unit to the first-stage impeller where it is dispersed into the incoming air.

The air casing also provides external mountings on the top for the oil cooler, and on the port side for the water/methanol unit, the torque meter pressure transmitter, and the engine data plate. On the starboard side are the mountings for the starter motor, feathering pump, and propeller controller unit.

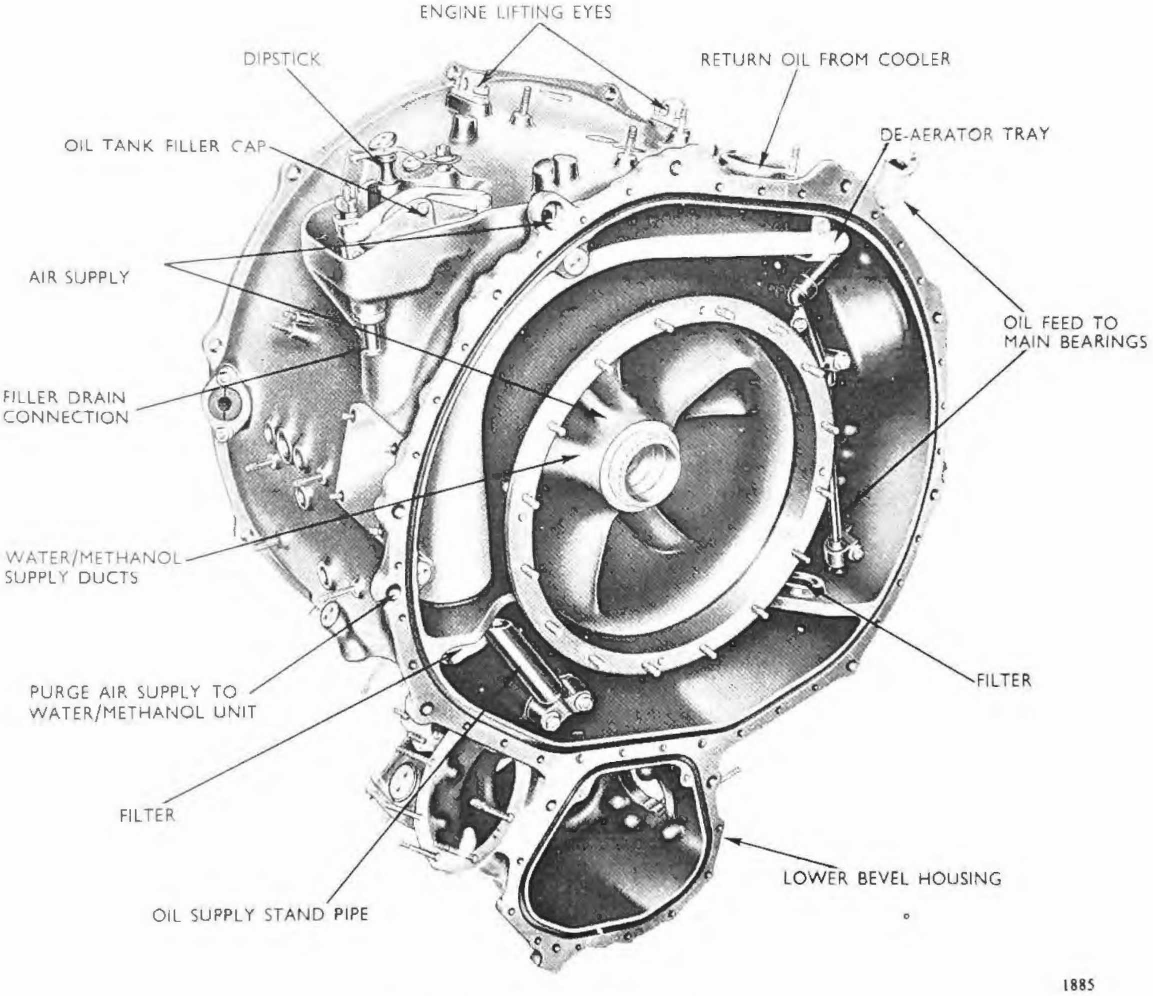


Fig. 2 Air intake casing — rear view

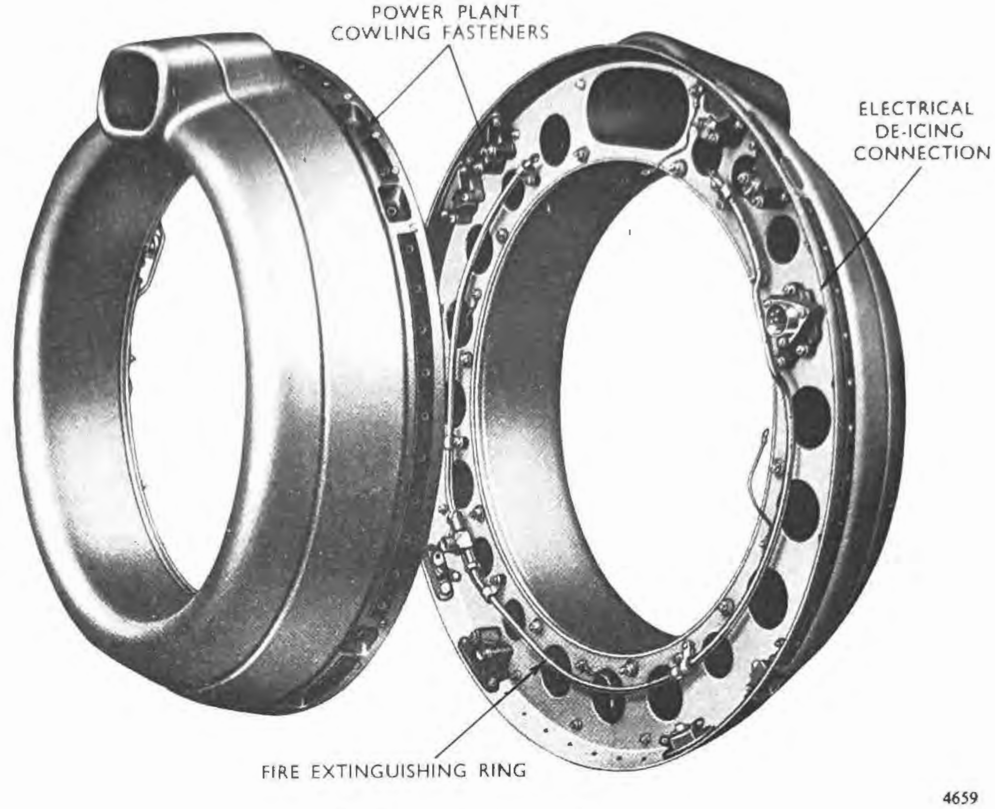


Fig. 3 Air intake cowling

The feathering pump draws its oil supply through an external pipe originating near the oil drain plug.

Oil tank

The oil tank is formed between the annular cavity in the intake casing and a steel plate bolted to the rear face. By this arrangement some heat transference occurs between the oil and the air flow to the compressor, thereby permitting the use of a smaller oil cooler than would otherwise be possible.

A combined de-aerator tray and hotwell directs oil from the cooler to the lower half of the oil tank. Two cast partitions, each carrying a gauze filter, divide the tank and ensure that oil passing into the lower section is filtered before being supplied to the engine.

A stand pipe fitted in the base of the tank carries oil to the pressure pump in the lower bevel housing and ensures that a sufficient quantity of oil is always available for feathering.

The filler for the tank incorporates a cylindrical metal baffle to keep out foreign matter, and at its lowest extremity is connected to one of the tank filters, the whole being removable for cleaning. A dipstick, marked in pints required to fill, adjoins the filler.

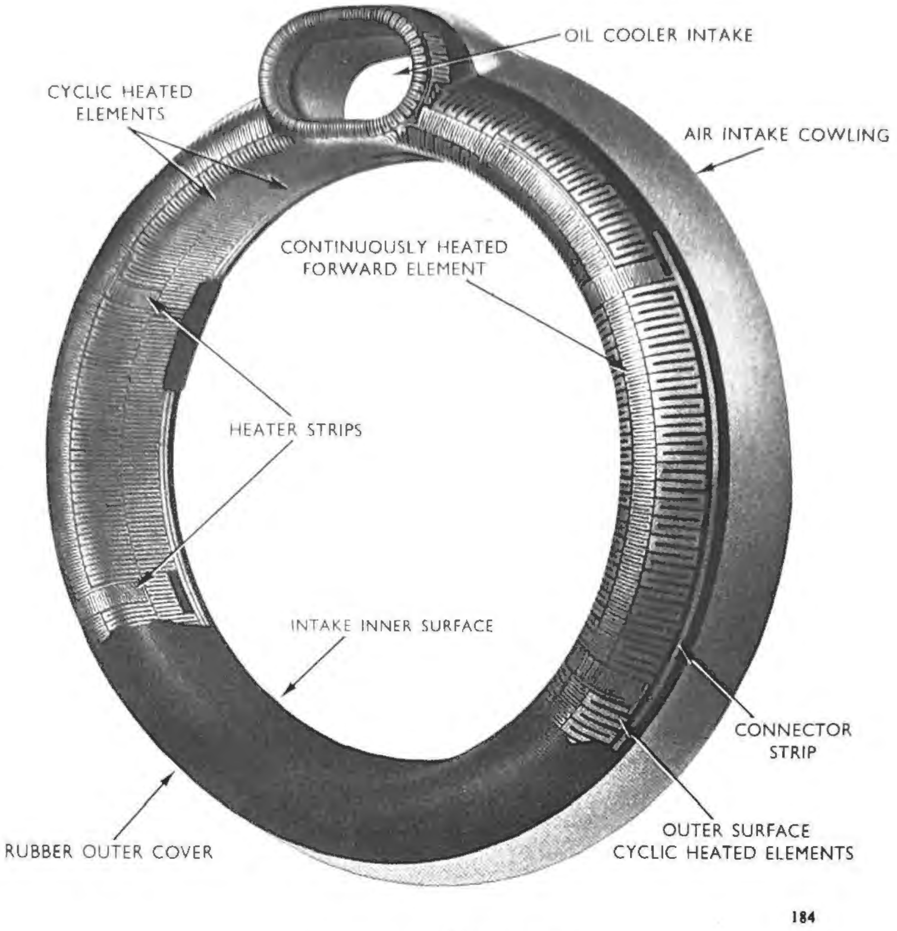


Fig. 4 **Air intake de-icing**

An overflow tray, fitted with a drain pipe, is embodied in the casting adjacent to the filler cap. Oil tank drainage is by a screwed plug and pipe connection at the base of the intake casing.

Electrical heater elements

During cold weather operations, ice is prevented from affecting engine performance by an electrical heating system which melts and breaks up any ice tending to form in the air intake. Icing up of the fuel filter is prevented by a hot air system, described in 75-1-1.

To avoid excessive ice formation, electrical heater elements are fitted around the air intake cowling and the oil cooler intake, and may be energized when required. Both anti-icing and de-icing techniques are employed by using continuously heated and intermittently heated elements.

The heater elements are supplied with current by a three-phase gearbox-driven alternator; the current to the de-icer pads is directed by a time switch which will give fast or slow cycling. A manual switch is provided to select the fast or slow sequence periods of the cycling control, and permit a longer period of heating at very low temperatures.

A continuously heated anti-icing element prevents ice from forming on the leading edge of the intake, where ice build-up would normally commence. Behind the leading edge, ice is allowed to form and is dislodged by the cyclic heating of the de-icer pads immediately behind the anti-icing element on the inner and outer intake surfaces. To ensure that this ice breaks away easily, it is divided into segments by continuously heated strips extending rearwards from the anti-icing element.

The cycling of the current permits the formation during the heat-off period of a thin layer of ice which acts as an insulator; when heating is resumed, the temperature of the pad increases more rapidly than on an uncovered surface, and the inner layer of ice adhering to the surface is easily melted and the remainder dispersed.

To prevent ice formation inside the intake, caused by water droplets running back and re-freezing, a further intermittently heated element, using a lower intensity current, is situated farther back on the inner wall of the intake.

Similar de-icing elements are fitted to the propeller and spinner, and provision is made on the engine for mounting the brush gear to feed these components.

ENGINE INTAKE COWLING - MAINTENANCE PRACTICES

1. Removal/Installation

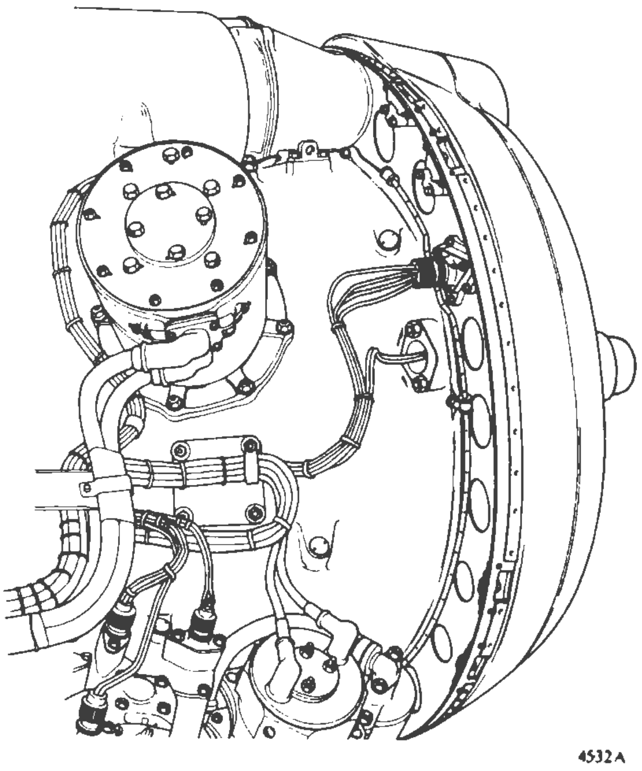
A. Remove the engine air intake cowling

(1) Remove the propeller and spinner as described in the aircraft maintenance manual.

(2) Sever the locking wire and disconnect the electrical harness plug from the de-icing socket connection on the rear face of the cowling.

(3) Disconnect the engine fire extinguishing system at the tee-piece on the left-hand side rear face of the cowling.

(4) Remove the nuts and spring washers which secure the cowling to the air intake casing and remove the cowling from the engine; remove the steel ferrule/rubber bush assemblies from the air intake casing flange.



Air intake cowling - right-hand side view
Fig.201

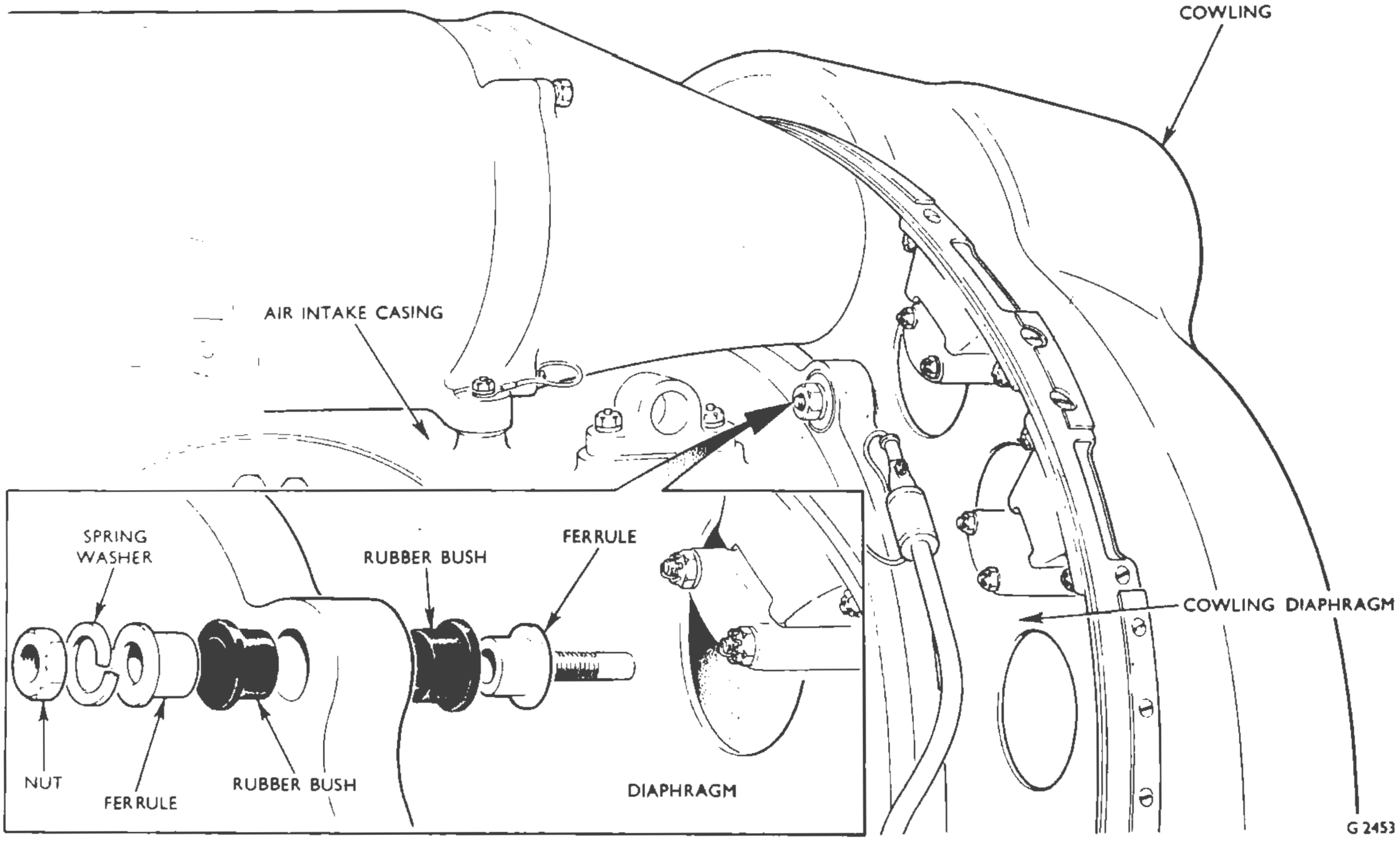
B. Install the engine air intake cowling

NOTE: Before fitting the cowling, ensure that the holes in the fire extinguisher spray pipes are not blocked.

(1) Examine the ferrule bushes for wear and deterioration; renew as necessary. Fit the bushes to the ferrules and locate the ferrules in the air intake casing flange (Fig.202).

(2) Fit the cowling to the air intake casing and secure the cowling, temporarily, with five equally-spaced nuts. Check that a clearance of at least 0.010 in. exists between the cowling diaphragm and the air intake casing and, if satisfactory, permanently secure the cowling with the appropriate spring washers and nuts. Tighten the nuts to the torque load specified in 89-3 and check that the 0.010 in. minimum clearance still exists; if the clearance is unsatisfactory, check that the ferrules and bushes are correctly assembled (Fig.202) and examine the cowling diaphragm for evidence of damage or distortion.

NOTE: If the correct clearance cannot be obtained, change the complete cowling assembly, or the diaphragm.



Ferrules and bushes - assembly detail
Fig.202

(3) Connect the engine fire extinguishing system at the tee-piece on the left-hand side rear face of the cowling.

(4) Connect the electrical harness plug to the de-icing socket connection on the rear face of the cowling; wire-lock the plug using 0.028 in. diameter stainless steel wire.

(5) Fit the propeller and spinner as described in the aircraft maintenance manual.

2. Adjustment/Test

A. Check the power plant ice protection system

(1) Ground run the engine at 12,800 r.p.m. and check the power plant ice protection system as described in 71-0, 'Adjustment/Test'.

3. Inspection/Check

A. Inspect the air intake cowling

(1) Inspect the rubber covering and de-icing elements for gashes, blisters, exposure of the heating elements or signs of overheating (i.e., hardening, crazing or heavy local blistering), and general deterioration.

NOTE: 1. Blisters normally indicate a breakdown of the bond between the cover laminations, cover and elements, or the cover and metal cowling.

2. Overheating, or a complete 'burn-out', can be caused through inflicted damage, defects in the thermal assembly or malfunction of the aircraft electrical system.

CAUTION: A DEFECT IN THE DE-ICING ELEMENTS CAN BE DIFFICULT TO ESTABLISH, PARTICULARLY AFTER A 'BURN-OUT' HAS OCCURRED. CHECK THE ASSOCIATED AIRCRAFT SYSTEM SUBSEQUENT TO A FAILURE OF THIS KIND, OR WHEN GENERAL OVERHEATING IS EVIDENT.

(2) If blisters, gashes, exposure of the heating elements, general deterioration, lack of adhesion or lifting of the rubber at the edges is evident, apply the following standards:

(a) Carefully cut open the blisters to permit examination of the heating elements. If the elements are not fractured or cracked and the lower rubber laminations have not deteriorated, the area affected may be repaired as described in topic 4, provided that:

(i) The blister or collection of blisters does not exceed an area of 2.000 sq.in. (after removing any part of the surrounding rubber area not securely bonded).

(ii) The areas affected are not less than 2.000 in. apart.

(iii) The areas affected do not exceed three in number.

(b) If gashes are evident in the rubber covering (outside the area of the heating elements) they may be repaired, however extensive, as described in topic 4. If, however, the gashes are in the area of the heating elements, they may only be repaired provided that:

(i) The heating elements are not damaged or misplaced.

(ii) Any one gash does not exceed 2.000 in. in length.

(iii) The gashes are not less than 2.000 in. apart.

(iv) The gashes do not exceed six in number.

(c) If exposure of the heating elements has occurred, the affected area or areas may be repaired as described in topic 4, provided that:

(i) The heating elements are not damaged or misplaced.

(ii) Each area of exposure does not exceed 2.000 sq.in. (after removing any part of the surrounding rubber area not securely bonded).

(iii) The areas affected are not less than 2.000 in. apart.

(iv) The areas affected do not exceed three in number.

(d) If, due to lack of adhesion, areas of the rubber covering are lifting at the edges, they may be repaired as described in topic 4, provided that:

(i) The areas affected do not exceed twelve in number.

(ii) Any one area does not exceed 2.000 sq.in.

(iii) The areas affected are not less than 2.000 in. apart.

(e) If the rubber covering has suffered general deterioration, it may be repaired as described in topic 4, provided that:

(i) Only the outside area of the covering is affected.

(ii) Any one affected area does not exceed 2.000 in. in length and 0.750 in. in width.

NOTE: To effect complete adhesion of the repair and prevent lifting, bevel the edges at the cut-away area.

(f) Examine the lacquer film on the rubber covering for damage or deterioration; if either is evident, touch-up or renew the lacquer film, as necessary, using Vulcaprene repair kit SQ.33 (supplied by Rolls-Royce Ltd.).

NOTE: Full instructions are included with the kit.

(3) If damage or deterioration affecting the intake cowling assembly is outside the specified standards, reject the cowling assembly and substitute a serviceable assembly.

B. Check insulation and circuit resistance

(1) Whenever a cowling assembly has been changed or minor repairs effected (4. Approved repairs), make the following insulation resistance and circuit resistance checks before ground running the engine to check the de-icing system.

NOTE: The acceptance limits specified in para. (2) and (3) apply to engines to pre-Mod.709 and Mod.709 standards; the acceptance limit specified in para. (4) applies only to engines which embody Mod.709.

(2) Using a 1,000 volt megger (insulation resistance tester, Major Megger, Evershed and Vignoles) check the insulation resistance between each terminal connection and 'earth'. Rotate the megger handle and check that the insulation resistance is not less than 2 megohms.

NOTE: As the intake cowling metal is anodised, it will be necessary to bare a small area to effect the 'earth' connection; on completion of the electrical checks, this area must be reprotected against corrosion (refer to T.S.D.594, O.P.330).

(3) Using a Cambridge Decade Wheatstone Bridge, check the de-icing system circuit resistance as follows:

(a) Connect the test leads to Wheatstone Bridge terminals X1 and X2, and to the terminals of the circuit being checked.

(b) Release the galvanometer clamp by selecting the FREE position on the switch.

(c) Operate the zero adjuster screw until the galvanometer registers zero on the dial.

(d) Set ratio switch A to X.1.

(e) Adjust controllers C, D, E and F to the equivalents, in turn, of the following values plus the known resistance value of the test leads.

Terminals	Resistance values
1 and 3 3 and 5 5 and 1	69.8 ohms max. 66.4 ohms min.
2 and 4 4 and 6 6 and 2	15.2 ohms max. 14.46 ohms min.

(f) Depress and rotate key B in a clockwise direction to 'lock-in'.

(g) Press and release key G and observe the galvanometer pointer deflection. Continue adjusting controllers C, D, E and F until no deflection is observed.

(h) Check that the circuit resistance, after deduction of test leads resistance, conforms to the values specified in the preceding table.

(4) Using a 1,000 volt megger, check the insulation resistance between circuit terminals 1 and 2, 3 and 4, 5 and 6. Rotate the megger handle and check that the insulation resistance is not less than 2 megohms.

4. Approved repairs

A. Effect minor repairs to the cowling assembly within the standards specified in 3. 'Inspection/Check'.

B. Prepare the affected area

(1) Using a sharp knife, carefully cut away any loose portions of rubber covering from the area to be repaired.

(2) Using abrasive paper, Chap.89-1, blend the edges of the cut.

(3) Using benzene or naphtha, Chap.89-1, on a clean lint free cloth clean the cavity thoroughly.

C. Application of filler cements

NOTE: 1. Adcora P6 is compounded from two substances, a black cement and a clear hardener.

2. Boscoprene 2114/5 is compounded from two substances, a white compound and a dark brown viscous compound.

Mix a sufficient quantity of materials in a clean container, to complete repairs.

D. Apply Adcora P6 to areas affected by small cuts, or lifting of rubber at the edges as follows:

(1) Using a small soft brush, apply the mix in succesive coats to the damaged areas, allowing each coat to dry before making a further application until the cavity is filled to the level of the surrounding area.

(2) When the cavity is filled, allow the cement to harden for a period in excess of two hours.

(3) Using abrasive paper, Chap.89-1, rub down the repair until the contour of the area is restored.

NOTE: Excess cement must be removed from the area of the repair to avoid the possibility of creating a temperature gradient at that point due to a build up on the element covering.

E. Apply Boscoprene 2114/5 to areas affected by blisters, gashes, exposure of heating elements or general deterioration as follows:

(1) Apply two coats of Bostik 1777, Chap.89-1, to the exposed elements.

(2) Using a pallet knife, or similar tool, apply Boscoprene 2114/5 mix until the cavity is filled to the level of the surrounding area. Allow the cement to harden for approximately one hour.

(3) Using abrasive paper, Chap.89-1, rub down the repair until the contour of the area is restored.

NOTE: Excess cement must be removed from the area of the repair to avoid the possibility of creating a temperature gradient at the that point due to a build up on the element covering.

DESCRIPTION

REDUCTION GEAR

The drive from the turbine shaft to the propeller is transmitted through a compound gear train providing two stages of speed reduction (fig. 1). Helical gears are used throughout the train.

The high speed gear train commences with the high speed pinion which is directly driven by the separate turbine-to-reduction gear drive shaft. The rear end of the high speed pinion gearshaft is supported by a steady bush, fitted into the front bore of the first-stage compressor shaft.

The high speed gears drive the three equally spaced layshafts, which are mounted on roller bearings in two panels supported by the reduction gear casing.

The low speed train consists of gears on the front end of the layshafts meshing with the rotating annulus gear bolted to the propeller shaft driving disc.

The propeller shaft is supported by roller bearings housed in the front panel and in the reduction gear front cover. A ball bearing, fitted immediately behind the roller bearing in the front cover, takes up axial thrust on the shaft.

A pressurized labyrinth seal, situated just forward of the two front cover bearings, prevents any leakage of oil from around the propeller shaft.

A torque meter is incorporated in the reduction gear to give an indication of propeller shaft torque in terms of oil pressure.

A transfer seal assembly, located inside the rear end of the propeller shaft, provides the means of transferring pitch operating oil to the propeller oil lines arranged within the shaft.

The drive from the starter motor is transmitted to the high speed pinion through a clutch and disengaging pawl mechanism as described in 72-4. An inclined shaft and bevel gears, driven from the lower layshaft, transmits the drive to the lower bevel housing.

The meshing points of all gears are lubricated by oil jets; an oil jet, directed up the centre of the high speed pinion shaft, lubricates the torsion shaft splines and the first-stage impeller front bearing. An additional jet lubricates the high speed pinion front bearing.

The propeller shaft front bearings are also lubricated by an oil jet and the propeller shaft rear bearing is lubricated by oil leaking past the propeller oil transfer seals.

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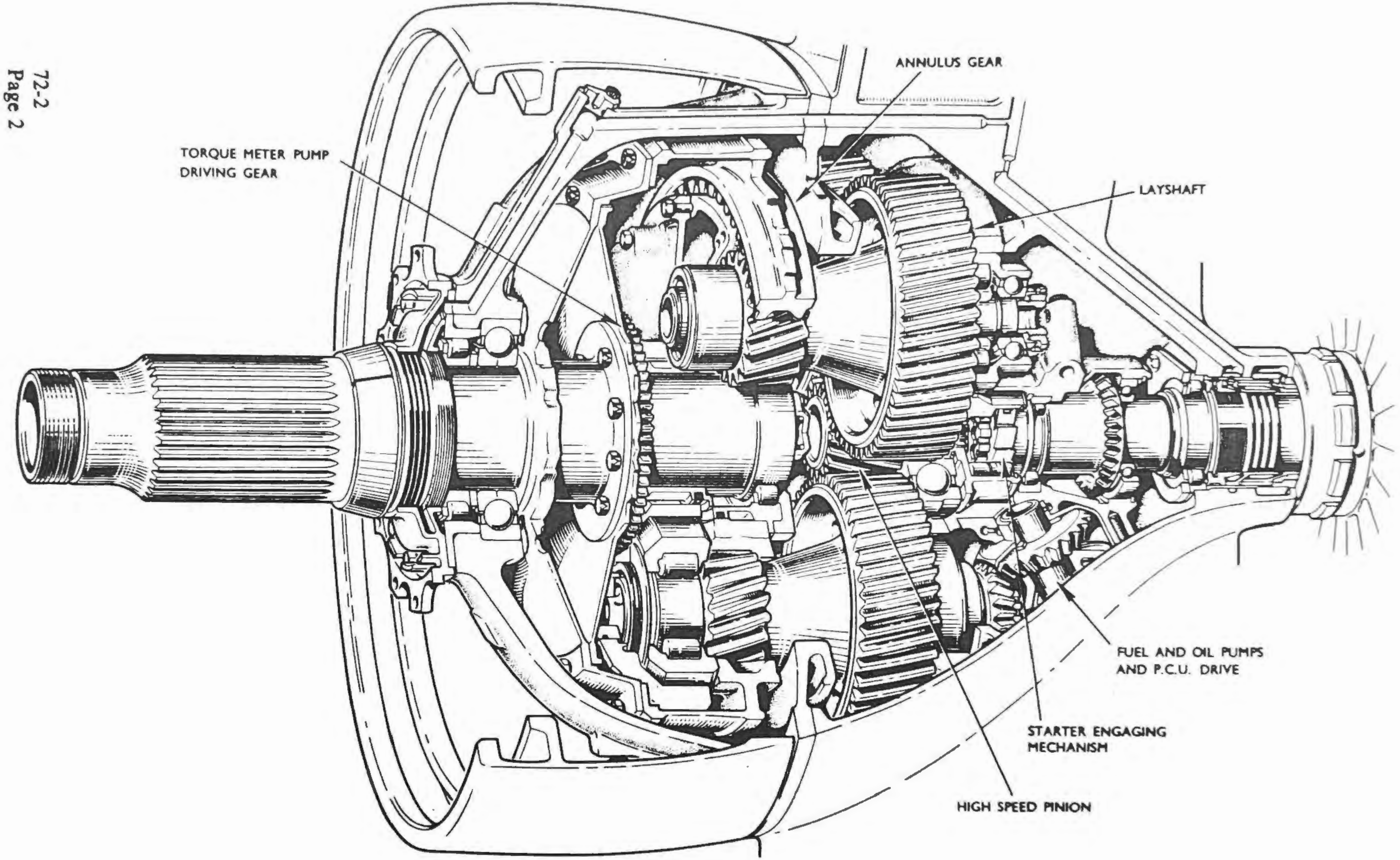

ANNULUS GEAR
TORQUE METER PUMP DRIVING GEAR
LAYSHAFT
FUEL AND OIL PUMPS AND P.C.U. DRIVE
STARTER ENGAGING MECHANISM
HIGH SPEED PINION

2539

Fig. 1 Reduction gear

TORQUE METER

When torque is being transmitted to the propeller shaft, an axial thrust is produced between the helical teeth of the three reduction gear layshaft driven gears and the high-speed pinion, and between the helical teeth of the layshaft driving gears and the propeller shaft annulus gear.

The resulting forward thrust is proportional to the torque transmitted through the gear train.

Each layshaft is mounted on roller bearings, allowing end float which is limited by mechanical stops on a shaft passing through the centre of each layshaft. These limit shafts rotate with the layshafts and each is axially located by a ball bearing at the rear end.

The forward axial thrust produced by the helical gears is opposed by oil pressure acting on a piston face at the forward end of each layshaft. All three pressure cylinders are interconnected and are supplied with oil from a gear-type positive displacement pump, delivering a flow proportional to engine speed; the pump is situated on the housing of the three layshaft front bearings, and is driven by a spur gear secured to the propeller shaft driving flange.

The piston in the lower layshaft (fig. 2) is arranged to open a control port as it moves rearwards and this permits the torque meter oil to spill and join the reduction gear return oil. At steady running conditions the axial load along the layshafts, due to torque, is balanced by the oil pressure. Increase in torque will move the layshaft forward and reduce the spill from the control port until the oil pressure has risen sufficiently to restore a balance.

If the engine speed is increased at constant torque, the increased delivery from the torque meter pump will cause a momentary pressure rise, and move the layshafts rearwards until the original pressure is restored by increased spill from the control port.

Thus torque meter oil pressure is affected only by engine torque variations and is therefore sufficiently representative of engine power to trigger the low torque automatic feathering system, and control the water/methanol injection.

Torque meter oil circuit

Low pressure engine oil from the reduction gear supply is boosted in pressure by the torque meter pump and fed into an annular ring which distributes it through drillings to the three torque meter pistons, the torque meter pressure transmitter, the water/methanol unit and the automatic feathering switch.

Torque meter oil pressure is controlled by the port on the lower torque meter piston. Surplus oil from the control port and the layshaft pistons is returned as scavenge to the engine main oil system.

Provision for lubricating the splines of the limit shafts is made by an oil jet directed up the centre of each layshaft, the returning oil lubricating the layshaft rear roller bearings and the thrust bearings at the rear of the limit shafts.

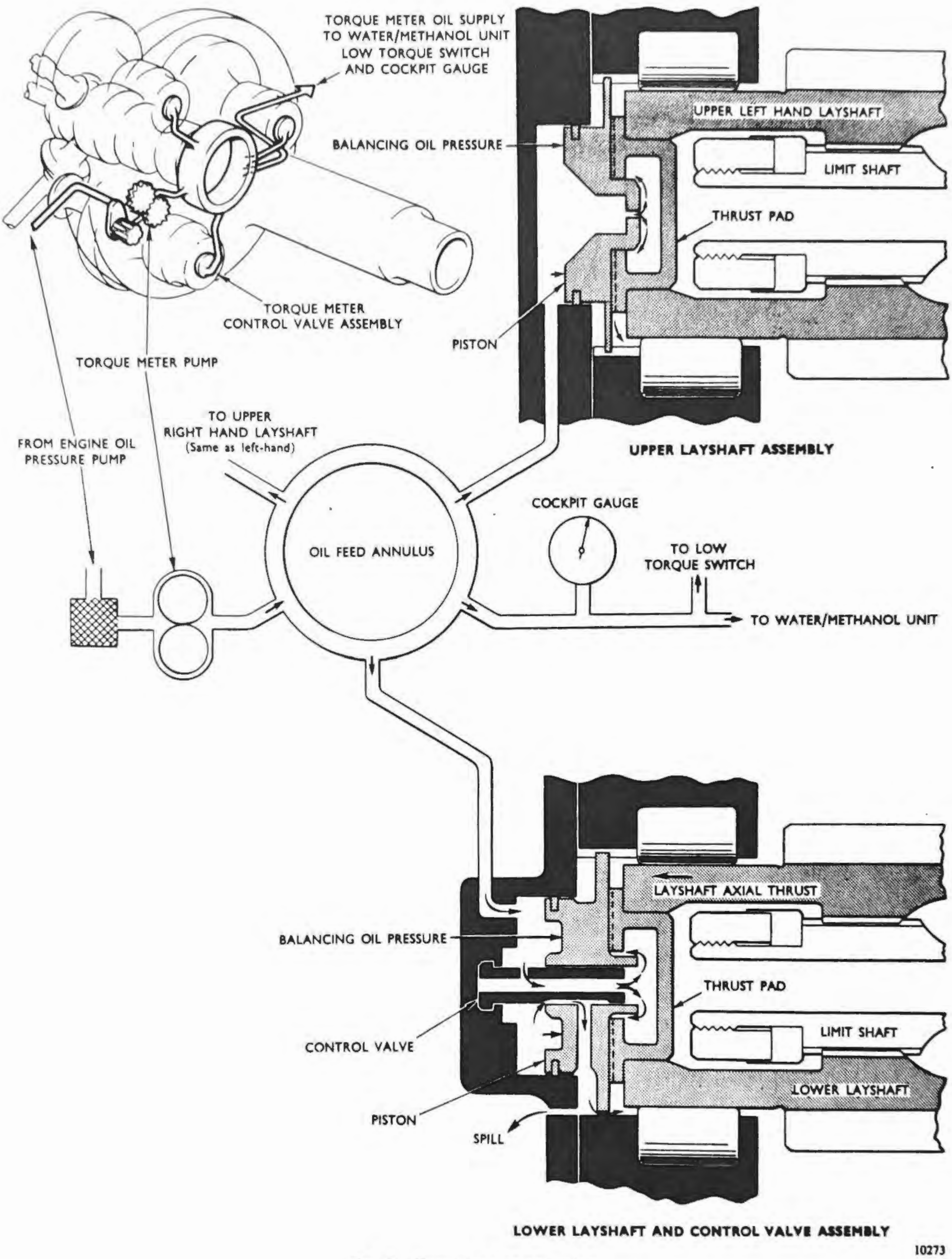


Fig. 2 Torque meter operation

REDUCTION GEAR - MAINTENANCE PRACTICES

1. General

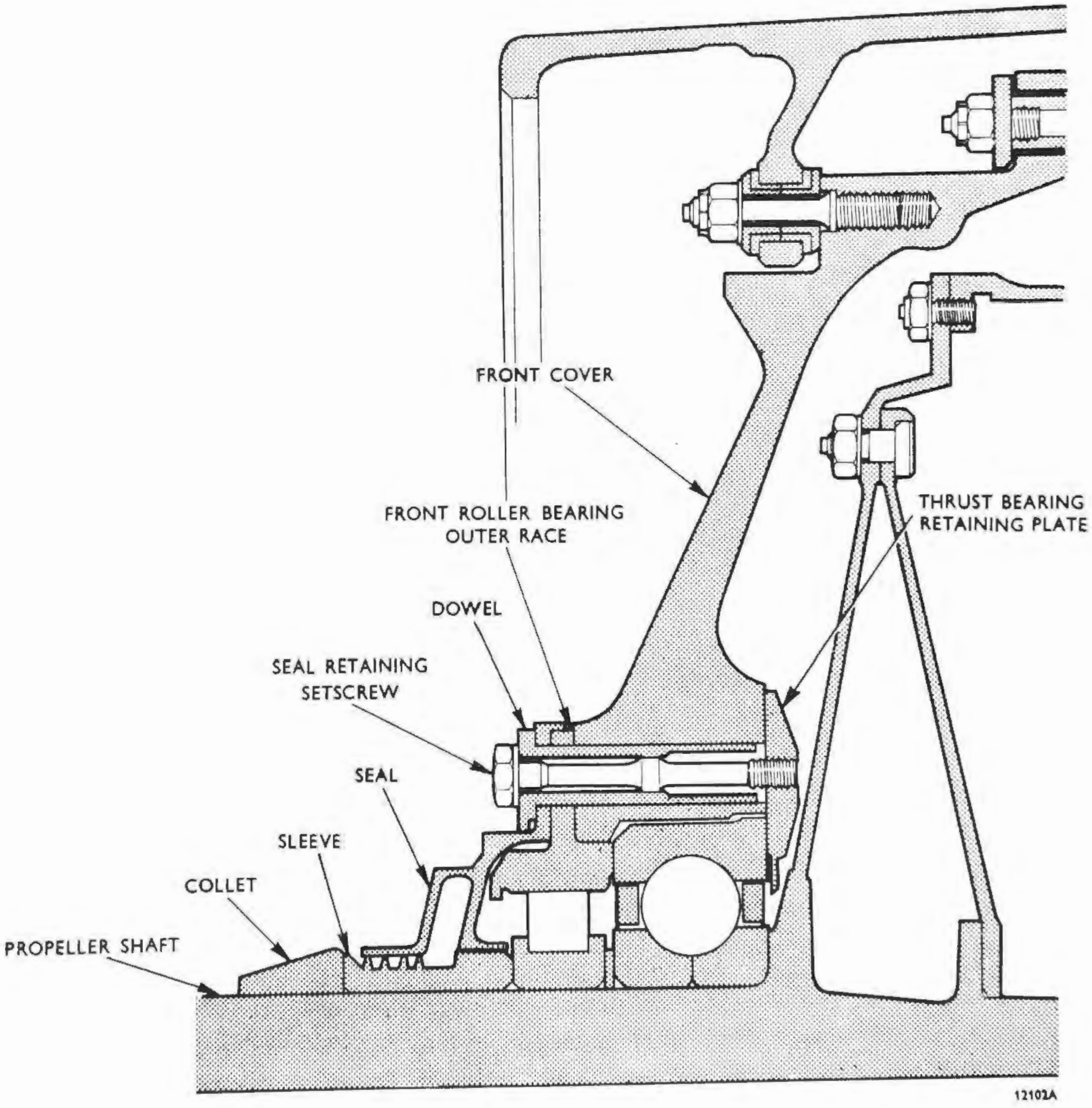
If leakage of the propeller shaft seal occurs in service, it may be necessary to change the seal 'in situ'. Return the rejected seal for overhaul.

2. Removal/Installation

A. Remove propeller shaft seal (Fig.201)

(1) Remove the propeller in accordance with the Aircraft Manual.

(2) Disconnect the propeller anti-icing and hub switch electrical connections at the brush gear housing.



Propeller shaft seal - Removal details
Fig.201

(3) Remove the brush gear housing in accordance with the instructions in the Aircraft Maintenance Manual.

(4) Withdraw the split-collet from the propeller shaft.

(5) Apply penetrating oil, specified in Chap.89-1, to the dowels and the seal sleeve, then unlock the 12 seal retaining setscrew tabwashers and remove a setscrew and dowel from the top dead centre and bottom offset centre positions, using extractor GU.19467/1 and plate GU.19624 to remove the dowels.

(6) Fit alignment pins HW.27652 to the holes from which the setscrews and dowels have been removed and retain the alignment of the seal, front roller bearing outer race, front cover and thrust bearing retaining plate.

(7) Slacken the 2 setscrews at 90 degrees to the alignment pins, then remove the remaining 8 setscrews and dowels.

CAUTION: BEFORE REMOVING THE SEAL, ON ENGINES EMBODYING MOD.1509 (S.B.No.Da72-336), POSITION A RECEPTACLE BENEATH THE FRONT BEARING ASSEMBLY TO COLLECT THE 32 FRONT ROLLER BEARINGS.

(8) Tap the lugs on the seal housing with a hide-faced mallet to separate the seal from the front bearing outer race. When the seal is free from the outer race, remove the remaining 2 setscrews and dowels, then withdraw the seal and the outer race completely.

(9) If the outer race adheres to the seal, remove the seal and race together and separate them after removal.

(10) Withdraw the seal sleeve from the propeller shaft. If difficulty is experienced, carefully tap the sleeve with a hide-faced mallet.

B. Install propeller shaft seal

(1) To locate the roller bearings, on engines embodying Mod.1509 (S.B.Da72-336), apply an adequate quantity of clean petroleum jelly, as specified in Chap.89-1, to the inner race, then position the 32 loose roller bearings around the track of the inner race.

(2) Remove the old jointing compound from both faces of the front bearing outer race and the mating face of the reduction gear front cover, using the solvent specified in Chap.89-1.

(3) Apply jointing compound, specified in Chap.89-1, to the joint face of the seal, both faces of the outer race and the mating face of the front cover.

Reduction gear - Maintenance practices (cont.)

(4) Align the outer race (refer to para.A.(5) and (6)) and fit it to the reduction gear front cover.

CAUTION: DO NOT INTERCHANGE PROPELLER SHAFT SEAL SLEEVES WITH SEALS OF A DIFFERENT MODIFICATION STANDARD, I.E. PRE-MOD.1414 WITH MOD.1414 OR MOD.1482.

(5) Fit the seal sleeve to the propeller shaft.

(6) Align the seal housing (refer to para.A.(5) and (6))and fit it to the outer race.

(7) Apply jointing compound, specified in Chap.89-1, to the threads of the 12 seal retaining setscrews.

(8) Fit 10 dowels, seal retaining setscrews and tabwashers.

(9) Remove the 2 alignment pins and fit the remaining 2 dowels, setscrews and tabwashers.

(10) Torque tighten the setscrews to the loading specified in Chap.89-3 and secure them with the tabwashers.

(11) Turn the propeller shaft and ensure that there is no internal fouling.

(12) Install the brush gear housing in accordance with the instructions in the Aircraft Maintenance Manual.

(13) Connect the propeller anti-icing and hub switch electrical connections to the brush gear housing and fit the split-collet to the propeller shaft.

(14) Install the propeller in accordance with the instructions in the Aircraft Maintenance Manual.

3. Adjustment/Test

A. Effect the propeller system functional checks as detailed in Chap.71-0, Sect.2 or Chap.72-0, Sect.2. as appropriate.

B. Effect the recommended engine ground-run as detailed in Chap.71-0, Sect.4. or Chap.72-0, Sect.4. as appropriate.

(1) On completion of engine ground-run, examine the spinner extension area for indications of oil leaks; if oil leaks are evident, reject the engine.

DESCRIPTION

COMPRESSOR

The compressor (fig. 1) is a single-entry, two-stage, centrifugal type and is directly coupled to the turbine. It consists of three main casings enclosing the compressor rotating assembly and first and second-stage diffuser rings.

The compressor casings, situated between the intake casing and the combustion chambers, form the major structural unit of the engine. The compressor interstage casing carries the engine mounting feet.

At maximum r.p.m. and standard atmospheric conditions, a compression ratio of approximately 5.5:1 is attained.

Where high atmospheric temperatures and reduced air density are encountered, the mass air flow required for take-off power can be restored by injecting water/methanol into the compressor.

OPERATION

Air pressure is raised within the compressor by the centrifugal action of its two impellers.

Air drawn into the compressor passes at an increasing velocity through the air intake on to the curved rotating guide vanes. These guide vanes, which are of steel to increase their resistance to fatigue, form the leading edges of the impeller vanes.

Each impeller imparts a rotary and outward acceleration in whirling the air from the eye of the impeller to its periphery.

When flung from the periphery, the airflow enters a series of divergent passages formed by the vanes of an encircling steel diffuser ring. On passing through the diffuser ring passages the airflow velocity is reduced, which results in increased pressure.

On leaving the diffuser, having attained its first stage of compression, the air is directed into the interstage casing. In this casing a series of radially curved passages, formed by the interstage guide vanes, impart pre-swirl to the airflow delivering it at controlled velocity and pressure to the rotating guide vanes of the second-stage impeller.

The second-stage impeller further accelerates the airflow and passes it into the high pressure diffuser ring where the final stage of compression is reached.

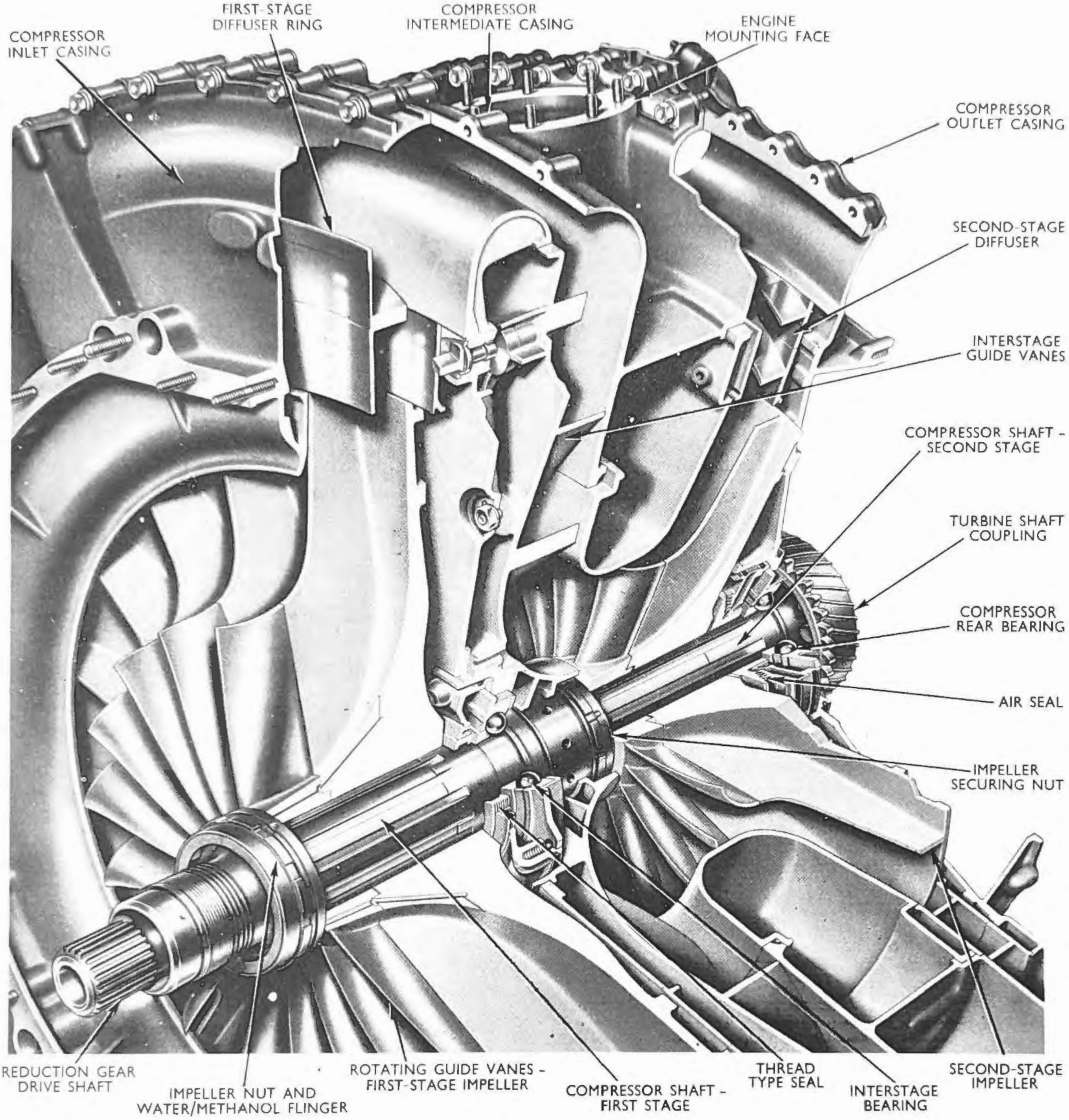


Fig. 1 Compressor

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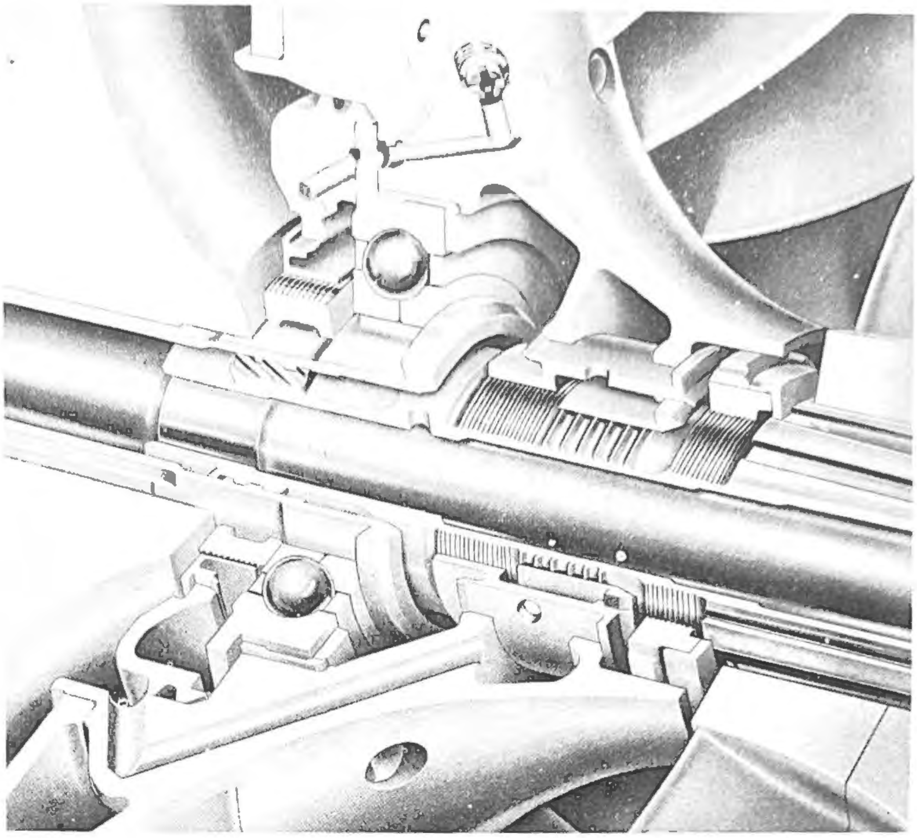


Fig. 2 Interstage bearing

On emerging from the diffuser, the pressurized airflow enters outlet elbows on the compressor rear casing. To smooth the airflow through its passage round the bend and direct it into the combustion chambers, cascade vanes are positioned in each elbow.

ROTATING ASSEMBLY

The compressor rotating assembly, consisting of two impellers and rotating guide vanes, is carried on a two-piece compressor shaft, the halves of which are coupled together by helical splines to minimize the bearing thrust loads under operating conditions. Each half carries one impeller and its rotating guide vanes secured on splines by a retaining nut.

The rotating assembly is supported at its forward end by a roller bearing in the air intake casing. A ball thrust bearing (fig. 2), positioned immediately behind the first-stage impeller, supports the interstage section. Similarly, a ball thrust bearing (fig. 3), positioned behind the second-stage impeller, supports the assembly at its rear end.

The roller race at the forward end of the assembly is lubricated by oil directed into the hollow high-speed pinion shaft from a jet on the reduction

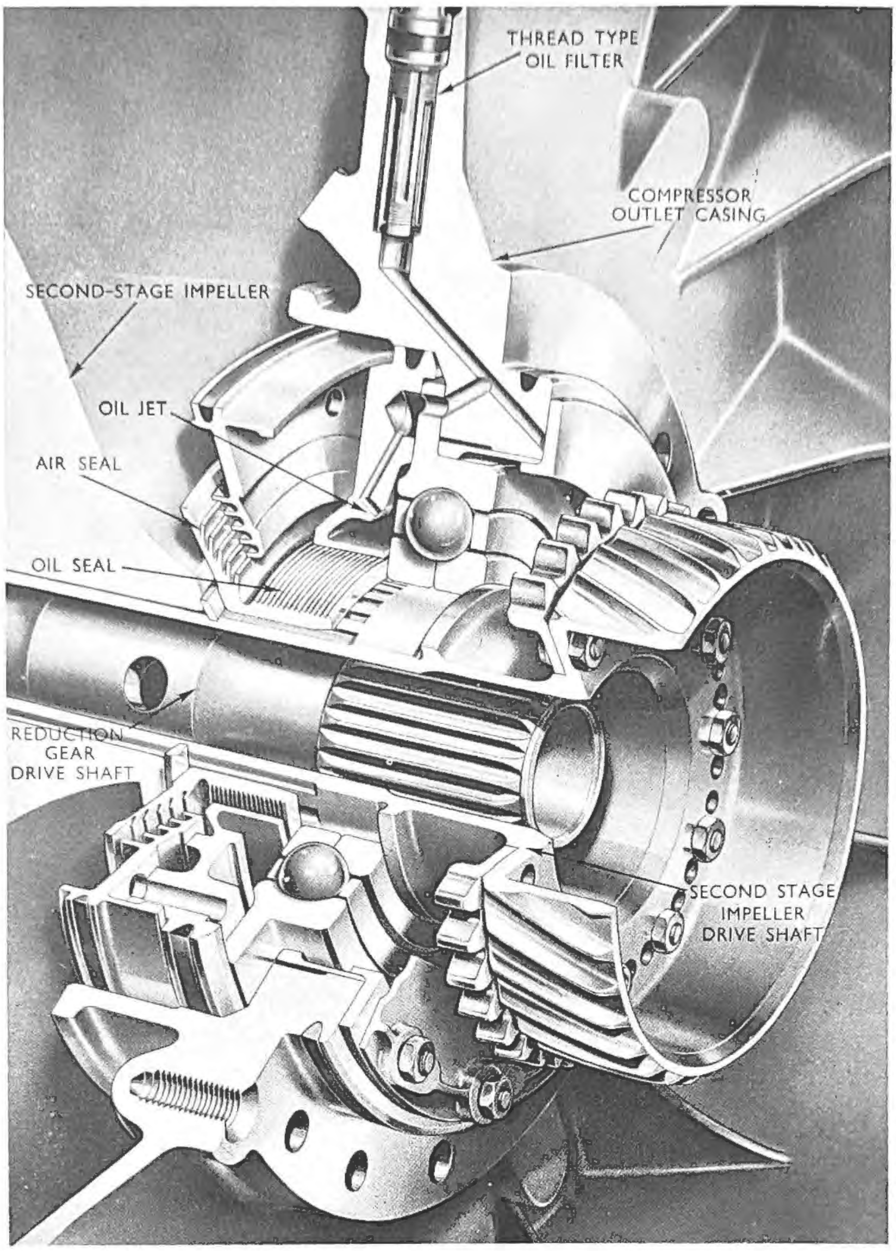


Fig. 3 Rear bearing

gear front panel. Oil reaches the bearing after passing first through the splines of the inner drive shaft, then through drillings in the high-speed pinion shaft steady bush and the impeller shaft.

The two ball thrust bearings are fed by independent oil jets; oil weirs are provided to ensure positive lubrication of the bearings under cold starting conditions. Thread and pressurized labyrinth-type seals prevent any leakage of oil into the compressor casings.

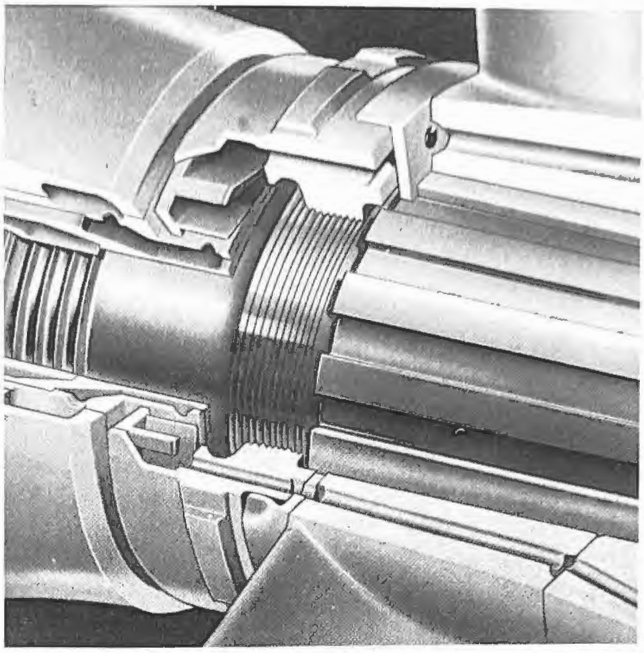


Fig. 4 Impeller nut and water/methanol passages

Water/methanol passages

To restore the mass air flow to that required for take-off power at high atmospheric temperatures, water/methanol may be injected into the main airstream in the first stage of the compressor.

Water/methanol fluid enters the hollow retaining nut securing the first-stage impeller (fig. 4), where annular vanes integral with the nut pick up the fluid and transfer it through passages in the rotating guide vanes and impeller hub to a series of radial drillings in the impeller body. The water/methanol is then flung outward from the impeller drillings and atomized within the compressor by centrifugal force.

SUBSIDIARY AIRFLOWS

Tappings are taken from both stages of the compressor to purge the water/methanol passages and provide sealing and cooling air for the bearings and turbine.

When required, hot air from the second-stage compressor is supplied to the fuel filter de-icing system as described in 75-1-1. The gate valve for controlling this hot air supply is carried on the underside of the compressor casing.

COMPRESSOR - MAINTENANCE PRACTICES

1. Inspection/Check

   A. Inspect the first stage rotating guide vanes

      (1) With the aid of a strong spotlight, examine the outer half of the rotating guide vanes for any damage in the form of cracks, cuts, nicks or dents, paying particular attention to the leading edges.

      (2) If any doubt exists as to the extent of any damage, examine the inner half of the rotating guide vanes using the Introscope Model 1860/A3, or a similar viewing instrument.

   B. Reject the engine if:

      (1) On the outer half of any vane (that portion which can be seen without visual aids) any crack, cut, nick or dent has incised or distorted the leading edge to a depth greater than 0.050in.

      (2) On the inner half of any vane (that portion which can be seen only with the aid of a viewing instrument) any crack, cut, nick or dent has incised or distorted the leading edge to a depth greater than 0.025in.

      (3) Any sharp cuts or nicks are accompanied by visible or suspected cracks.

   C. Inspect the front, intermediate and outlet casings

      (1) Examine the front compressor casing for cracks, particularly in the area immediately adjacent to the air intake mounting flange and the rear flange/volute radius; refer to Table 1 and Fig.201.

      (2) Examine the intermediate casing for cracks, particularly the area of the engine mounting feet and the hot air gate valve mounting; refer to Table 1 and Fig.201A and 201B.

      (3) Examine the outlet casing for cracks, particularly the area adjacent to the rear of the top mounting foot and the No.1 diffuser stud boss on the right-hand side of the breather outlet elbow; refer to Table 1 and Fig.201C.

         NOTE: If the costs of a high salvage/repair rate of casings at overhaul, are exceeded by service/economic considerations the bracketed crack limits in Table 1 may be used. Use of these limits however, entails a higher inspection frequency.

Compressor - Maintenance practices (cont.)

CAUTIONS: 1. CHECK CRACKS INDICATED THUS * IN TABLE 1 FOR GROWTH AT PERIODS NOT EXCEEDING 20 HOURS.

2. CHECK CRACKS INDICATED THUS † IN TABLE 1 FOR GROWTH AT PERIODS NOT EXCEEDING 50 HOURS.

3. MARK ACCEPTABLE CRACKS AT EACH END AND CHECK FOR GROWTH AT CONVENIENT INSPECTION PERIODS NOT EXCEEDING 75 HOURS.

4. IF THE LIMITS GIVEN IN BRACKETS ARE USED, CHECK THE CRACK(S) FOR GROWTH AT PERIODS NOT EXCEEDING 20 HOURS.

TABLE 1

Location of crack	Reject engine if:	The aircraft may be flown back to base provided:
Front compressor casing, particularly the area immediately adjacent to the air intake mounting flange refer to Fig.201	There is a circumferential crack longer than 6 in. or a radial crack of any length extending into the L.P. volute	The circumferential crack does not exceed 12 in. and does not extend radially into the L.P. volute.
Front compressor casing, particularly the area of the rear flange/volute radius; refer to Fig.201	(a) There is a circumferential crack longer than 8 in. (b) Cracks occur at right angles to an acceptable circumferential crack and have propagated into the L.P. volute to a length exceeding 1 in. * refer to CAUTION 1. (c) 'Forking of any crack occurs in this area	The circumferential crack does not exceed 12 in. and does not extend radially into the L.P. volute to a length exceeding 1 in. and no 'forking' is evident.
Intermediate casing, particularly the area of the engine mounting feet and the hot air gate valve mounting; refer to Fig.201A and 201B.	(a) There is a circumferential crack at the front flange longer than 8 in. or less if the width of the crack exceeds 0.003 in. or if there is a series of cracks each less than 8 in. with a cumulative length more than 20 in.	(a) The crack in the front flange does not exceed 12 in. and the width of the crack does not exceed 0.003 in.

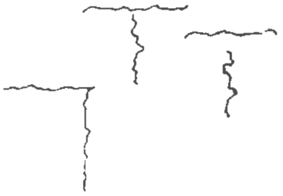
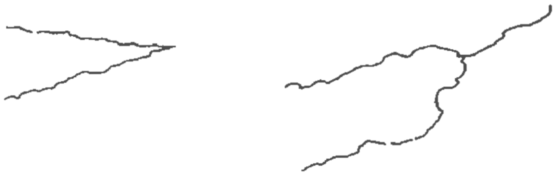
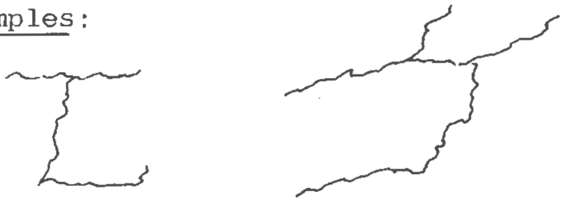
Compressor - Maintenance practices (cont.)

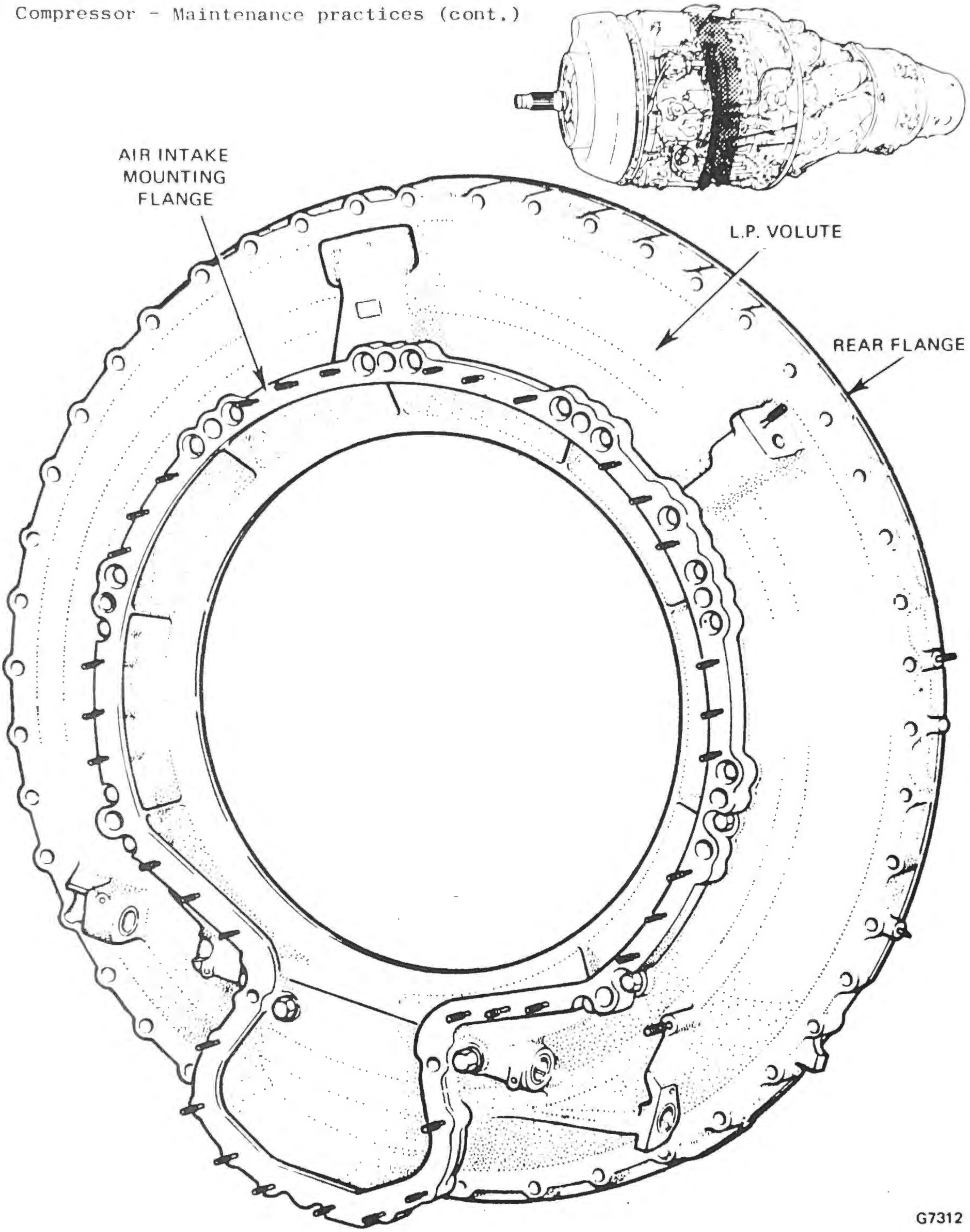
Table 1 (cont.)

Location of crack	Reject engine if:	The aircraft may be flown back to base provided:
Intermediate casing particularly the area of the engine mounting feet and the hot air gate valve mounting; refer to Fig.201A and 201B (cont.)	(b) There is a crack at the rear flange longer than 7 in. (10 in)	(b) The crack in the rear flange does not exceed 11 in
	(c) There is a crack at the L.P. volute longer than 5 in. (7 in.)	(c) The crack in the L.P. volute does exceed 8 in.
	(d) Cracking occurs at the rear flange and also at the L.P. volute and the cumulative length exceeds 11 in. (14 in). The limit for individual cracks must not be exceeded.	(d) The cumulative length of cracks in the rear flange and the L.P. volute does not exceed 15 in.
	(e) Cracking occurs at right angles to circumferential cracks in the L.P. and H.P. volutes and these cracks propagate to a length exceeding 1.000 in. * refer to CAUTION 1.	
	(f) Axial cracks in the cylindrical portion between the L.P. and H.P. volutes propagate into either volute	
Outlet casing, particularly the No.1 diffuser stud boss; refer to Fig.201C	There is a crack longer than 4 in. (6 in.)	The crack does not exceed 6.500 in.

Compressor - Maintenance practices (cont.)

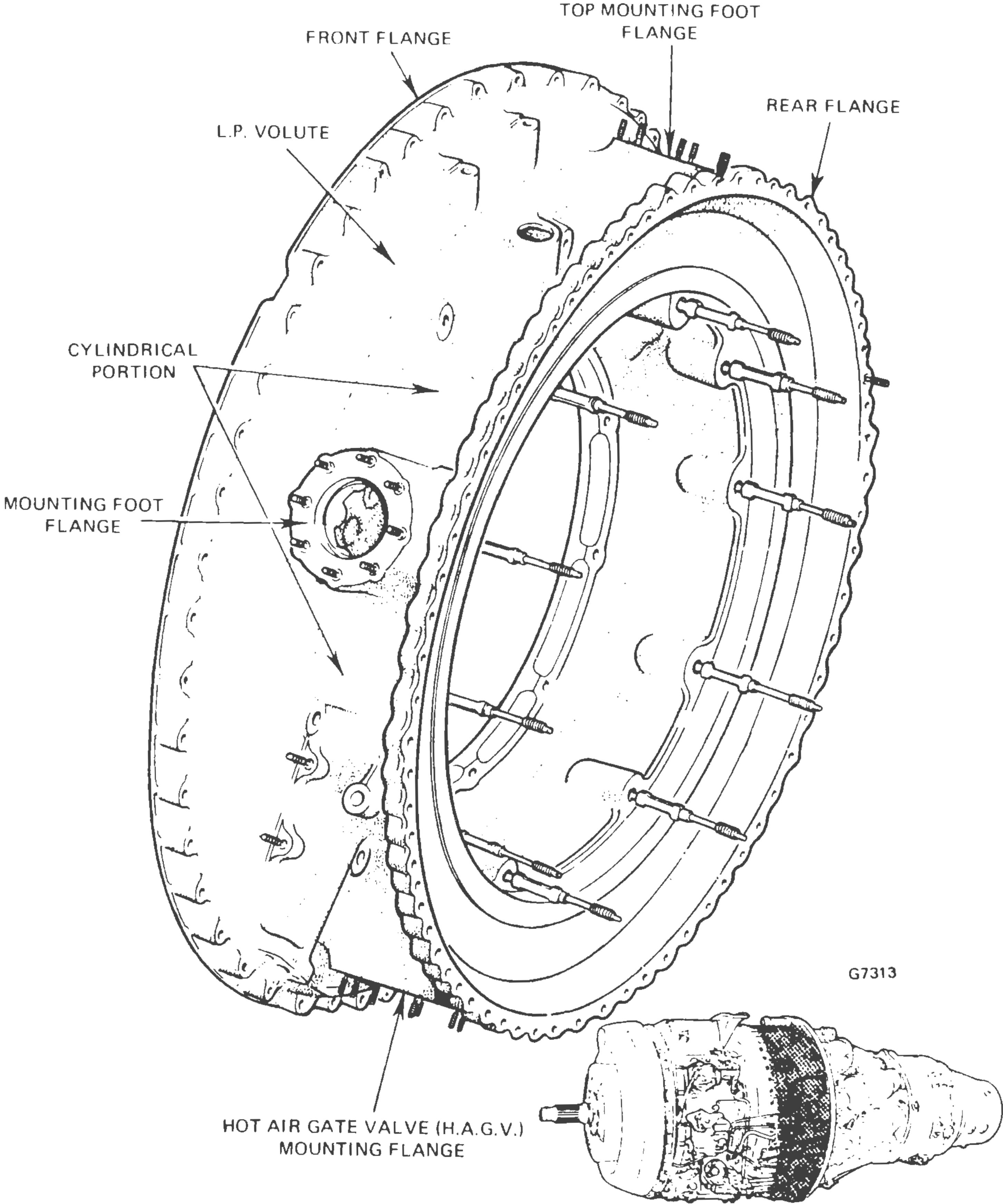
Table 1 (cont.)

Location of crack	Reject the engine if:	The aircraft may be flown back to base provided:
Outlet casing, particularly the area adjacent to the rear of the top mounting foot: refer to Fig.201C	There is a circumferential crack longer than 8 in. † refer to CAUTION: 2	The crack does not exceed 10 in.
Outlet casing, forked cracks	There is a circumferential crack longer than 4 in. (6 in.) in conjunction with an axial crack longer than 1 in. (1.5 in.)	
Examples: Acceptable 	Unacceptable 	
General	(1) Any multiple cracking of this type is found: Examples:  (2) The total length of overlapping cracks at each or any of the previous locations exceeds the limit	



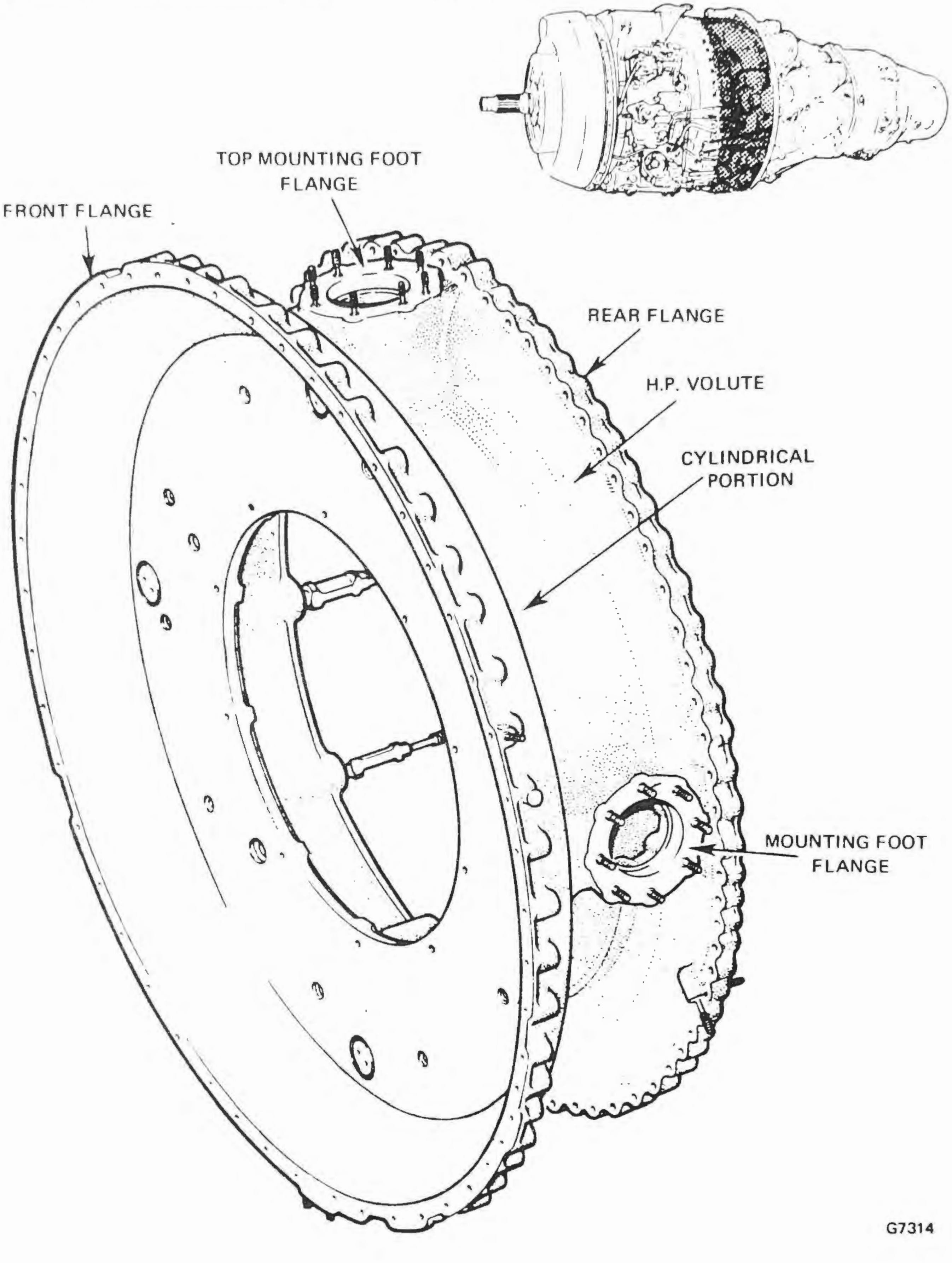
Front compressor casing
Fig.201

Compressor - Maintenance practices (cont.)

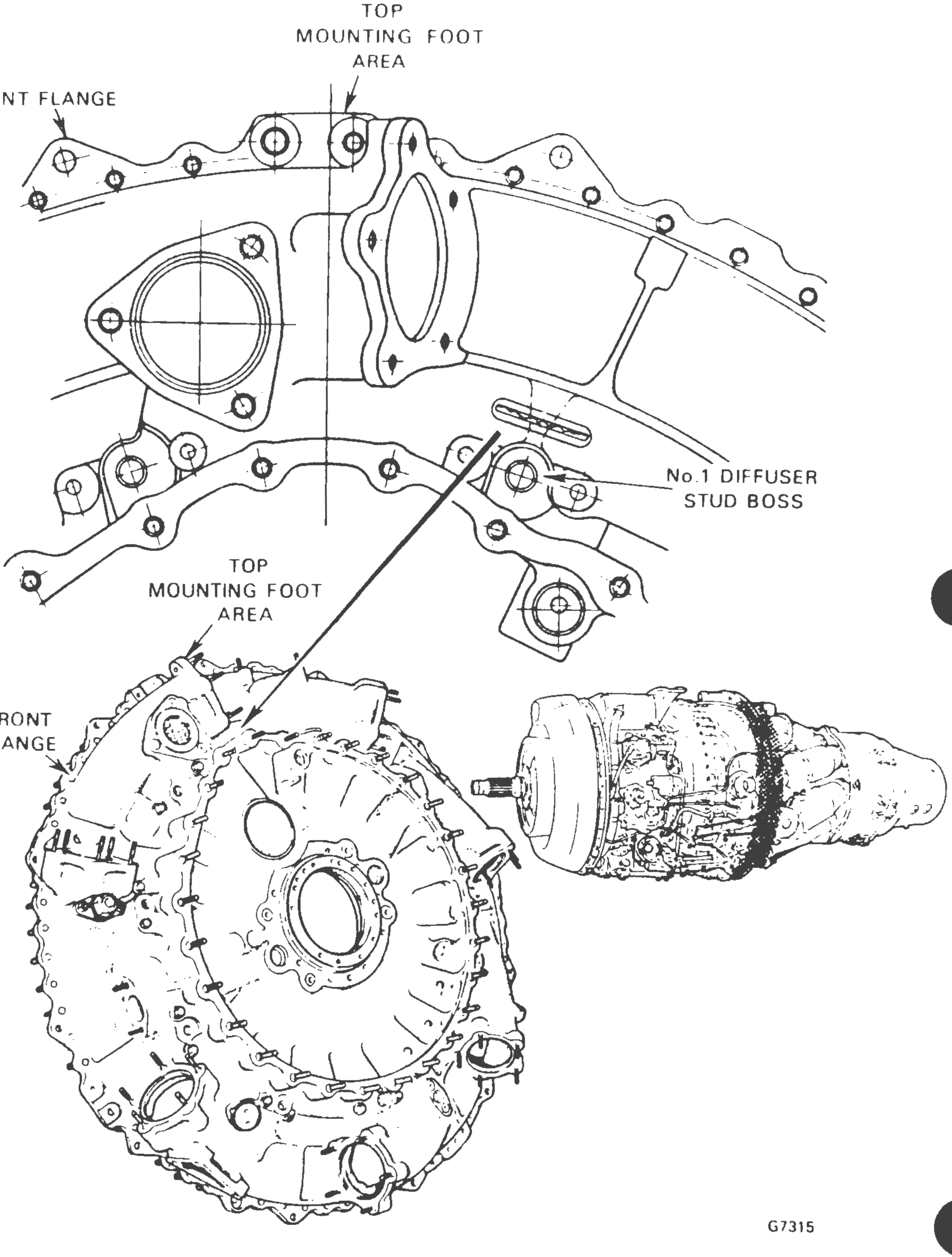


Intermediate compressor casing
Fig.201A

Compressor - Maintenance practices (cont.)



Intermediate compressor casing
Fig.201B



Compressor outlet casing
Fig.201C

2. Cleaning

CAUTION: DO NOT CARRY OUT ENGINE CHECKS WITH THE CLEANING RIG IN POSITION.

A. General

The engine may suffer loss of power due to contamination of the compressor which can be caused by atmospheric pollution, the ingestion of oil from a leaking seal in the propeller or reduction gear, contaminated water/methanol, or solid matter induced by the air flow and accompanied by oil in suspension. These deposits will adhere to the impellers and casings, and subsequent build-up will substantially reduce compressor efficiency and thus, engine performance. This loss of performance due to contamination of the compressor can be restored by cleaning the engine internally by one of two methods, depending on the type of contamination.

Oil deposited on the compressor can be removed in the early stages while it is still wet by washing the engine internally with a specially prepared cleaning solution containing Turbo Cleaning Fluid Concentrate (Chapter 89); the mixture is sprayed into the engine intake while the engine is running, using the Rolls-Royce rig J.59824/1 (J.59821, spray ring and mounting harness only), or a suitable rig manufactured locally and capable of delivering six and one half gallons in 5 minutes.

If the deposit has hardened however, the washing method will be ineffective, and the compressor should be cleaned by the grit blasting method. This consists of releasing a measured amount of a dry, soft, lignocellulose grit cleaning agent (Chapter 89) into the engine air intake at a controlled rate while the engine is running, using the rig D.22012 (Fig.202) obtainable fron J. Curran Ltd., Curran Road, Cardiff, U.K. This method is also effective against wet contamination.

NOTE: An alternative cleaning rig which can be manufactured locally from the components specified in 'C. Soft blasting method' is shown in Fig.201D.

Soft blast the compressor if contamination is suspected before rejecting an engine for low torque pressure or a high turbine gas temperature. Effect soft blasting at periods of 2,350 and 3,750 engine hours in order to maintain power at an acceptable level during engine life.

NOTE: These periods are based on world-wide averages of performance deterioration at the extended overhaul lives now being achieved. Variation of these periods for individual operators may be permitted (by agreement between Rolls-Royce and the operator) if performance evidence is available.

B. Install the combustion chambers

(1) Before installing combustion chambers ensure, if applicable, that the identification on the burner and expansion chamber correspond (see Chapter 73).

(2) Visually examine the spherical joint ring and the split sealing rings and their appropriate mating faces on the combustion chamber for damage, frettage and wear, particularly if the chamber shows evidence of gas blows at these points. Clean up or renew the rings as necessary.

(3) If renewing the spherical joint ring it is important to check that the correct size replacement ring is used. Two sizes of ring may be encountered in service:

Standard size - Part No.RK.13296
0.040 in. o/size - Part No.RK.16732

NOTE: The latter joint ring, specified when Dart Repair Scheme 20, Part B or Part C (Overhaul Manual) has been embodied, can be identified by the four flats on the periphery; its mating combustion chamber is engraved D.R.S.20B or D.R.S.20C, near the positional markings on the expansion chamber. The appropriate size spherical joint ring will be supplied with all replacement chamber assemblies.

(4) Fit new interconnector sealing rings

(a) Pre-Mod.1473: if rubber sealing rings to either Mod.1140 or Mod.1147 standard are fitted, lubricate the rings with kerosine to Spec. D.Eng.R.D.2494 then fit one ring adjacent to the flange of the outer tube so that, when the interconnector is fitted, the ring will be trapped between the liner on the air casing interconnector boss and the flange of the outer tube; fit the other ring to the sealing ring groove in the outer tube.

(b) Mod.1473: if Mod.1473 is incorporated, fit a rubber sealing ring (to Mod.1451 standard) adjacent to the flange as described in (a); fit a piston type sealing ring and a curved washer to the sealing ring groove (refer to sealing ring arrangement, Fig.3A) and ensure that the split in the washer is diametrically opposite to the gap in the ring. Ensure that the curved washer has not sprung as it may not provide positive loading when the interconnector is fitted; use light finger pressure to restore a sprung washer to correct shape and position. Check that both the washer and the ring are free to rotate in the interconnector sealing groove.

Combustion section - Maintenance practices (cont.)

(5) Fit the interconnectors to the combustion chambers, ensuring that the longer interconnector is inserted into the boss nearer to the expansion chamber air casing joint flange. If interconnectors to Mod.1473 standard are being fitted take care to ensure that the curved washer does not distort and slip inside the piston ring thus preventing correct assembly.

NOTE: On pre-Mod.1147 engines the longer interconnector incorporates a trap for the securing bolt heads; on Mod.1147 engines, this trap is deleted and the bolts are entered from the shorter interconnector.

(6) Fit the two piston ring type seals, with the gaps diametrically opposed, to the groove in the rear end of the air casing. Smear the rings with grease specified in Chapter 89.

(7) Apply a thin film of jointing compound (Chapter 89) to the mating faces of the spherical sealing ring, the expansion chamber and the compressor outlet elbow.

(8) Pre-Mod.1632

(a) Fit a new rubber sealing ring to each end of each drain tube and lubricate seals with kerosine to Spec. D.Eng.R.D.2494.

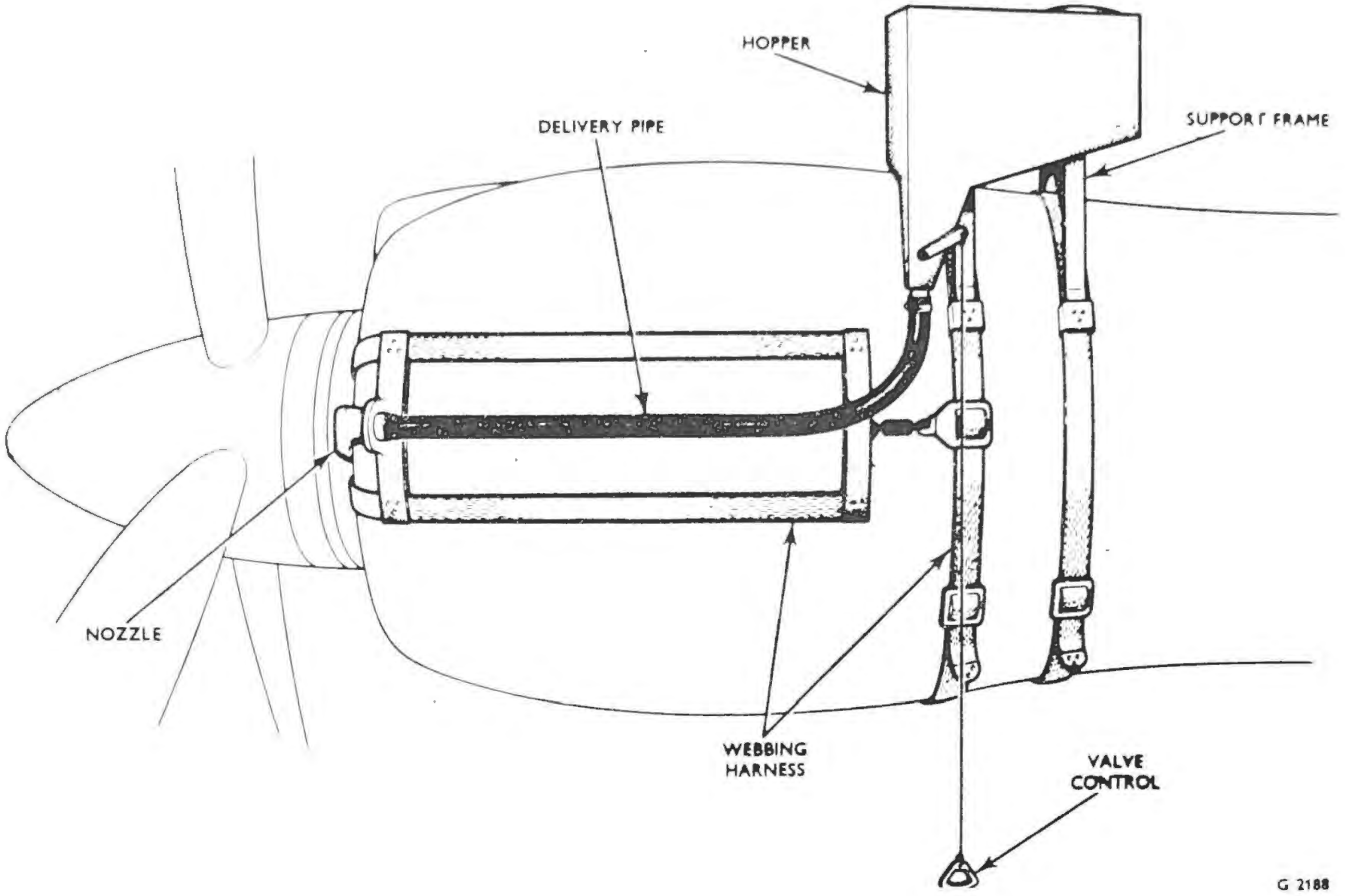
NOTE: Mod.546 and Mod.840 (Service Bulletin No.Da.Misc.2) engines have rubber sealing rings fitted to the drain tubes. Mod.1399 (Service Bulletin No.Da.72-269) introduces new rubber sealing rings to replace existing seals. It is essential that if any part of Mod.583 is embodied (aluminium alloy drain tubes), the drain tubes must be fitted with rubber sealing rings to either Mod.840 or Mod.1399 standard. Mod.1399 sealing rings must be fitted in sets.

(9) Mod.1632

(a) Fit a new rubber sealing ring to each end of each drain tube.

(b) Apply the primer D.C.4094, MS.2402 if using Silastic RTV731 or use Silcoset O.P.1 if using Silcoset 151, 152 or RTV106 to the areas to be coated with compound; refer to Fig.201A and Chapter 89-1.

(c) Apply Silastic RTV731, Silcoset 151, 152 or RTV106 to the areas shown in Fig.201A then, using the same compound, lightly smear the sealing rings; refer to Chapter 89-1.



Typical locally manufactured compressor cleaning rig assembled on engine air intake
Fig.201D

(b) A delivery pipe of 1 ½ in. diameter with a divergent nozzle, the pipe being so formed that the nozzle protrudes approximately 4 in. into the engine intake.

(c) An ON/OFF slide valve which can be set to give a specified flow rate, and which can be remotely operated, positioned in the lowest point of the hopper at the outlet to the delivery pipe to provide a gravity feed and control the flow of grit to the engine.

(d) A harness to secure the hopper and its delivery pipe to the engine cowling; the harness should include both front and rear straps (from hopper to intake) and straps to retain the hopper and delivery pipe in position.

NOTE: The force from the propeller slipstream at 13,000 r.p.m. should be taken into account when manufacturing the harness straps.

(e) The rig should be arranged and calibrated so that a constant flow of cleaning agent at the rate of 4 to 5 lb./min. is obtained when the control valve is opened at an engine speed of 13,000 r.p.m.

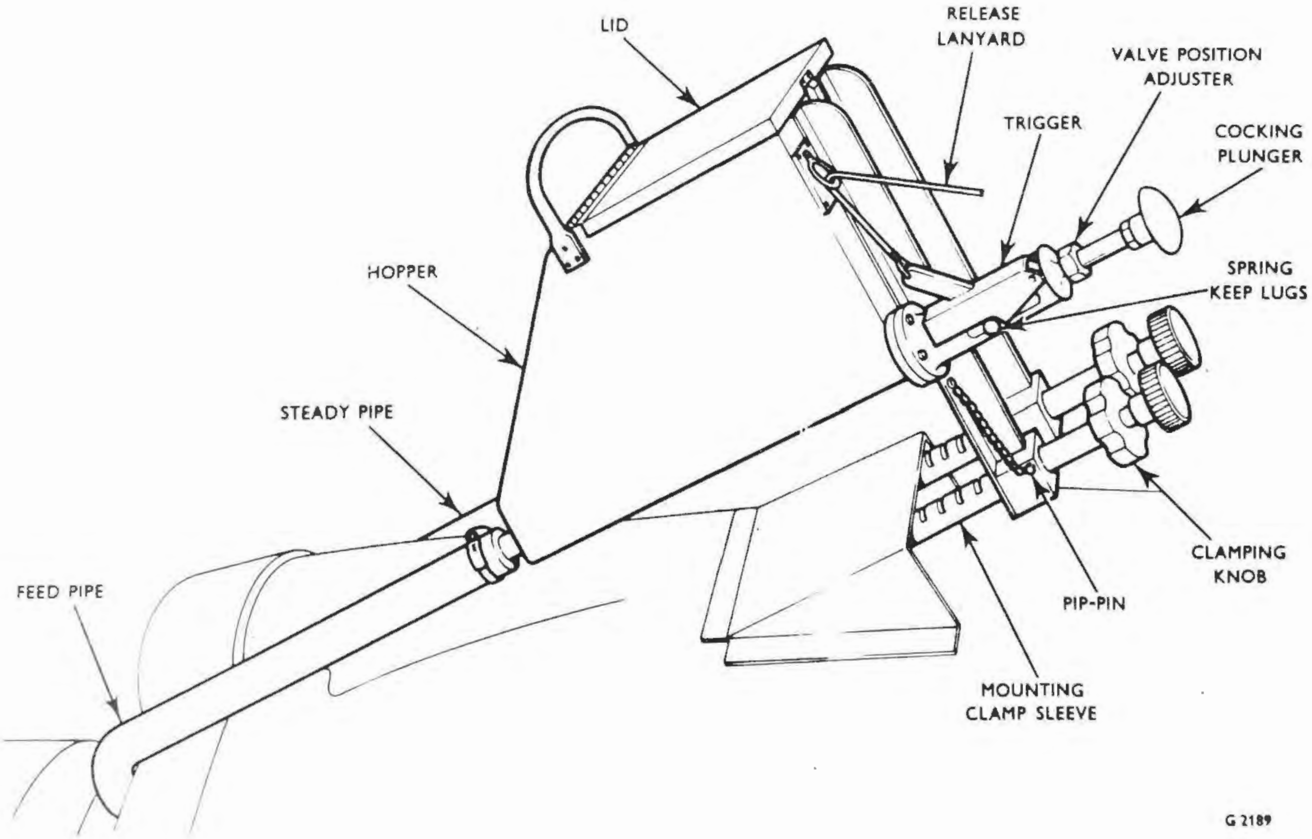
(2) Prepare to clean the compressor.

(a) Examine the propeller spinner extension, reduction gear and air intake casings, and the visible surface of the first-stage impeller and rotating guide vanes for signs of oil leakage; rectify leaks before proceeding with compressor cleaning and clean off any oil traces using white spirit.

(b) Disconnect the F.C.U. capsule ram air pipe from the connection on the air intake casing and blank off the pipe and connection.

(c) Blank off the ram air hole in the air intake lower strut and secure the blank in position.

(d) Disconnect the pressure air supply pipe from the connection on No.2 compressor outlet elbow (where applicable) and blank off the connection and pipe end.



Compressor cleaning rig D.22012 assembled on engine air intake
Fig.202

(d) Remove the hot air gate valve (75-1-1), then blank off the compressor interstage casing hot air outlet and the outlet duct connection located on the engine fireproof bulkhead; use suitable locally manufactured blanks.

NOTE: If suitable blanks are not available, compressor cleaning may be effected with the valve in-situ provided that the instructions, detailed in para.(6) (b), are complied with.

(3) Assemble the cleaning rig (D.22012) Fig.202.

(a) Mount the rig hopper on the top of the intake cowling with the delivery pipe on one side of the oil cooler fairing and the 'steady' pipe on the other side.

(b) Hook the curved ends of the delivery pipe and steady pipe into the air intake.

(c) Remove the pip-pin securing each adjustable mounting clamp sleeve to the rear of the hopper and locate each foot on the front flange of the oil cooler air outlet duct inside the outlet vent on the cowling.

(d) Adjust the mounting clamp sleeves and lock them with the pip-pins, then tighten the large clamping knobs and secure the clamp feet onto the oil cooler and outlet duct flange until the rig is firmly mounted in position.

(e) Adjust the hexagon on the valve position locator at the rear of the valve body until a valve opening of 1.125 in. is obtained; this opening will give a grit flow rate of approximately 5 lb./min.

(f) Press the knob, on the spring-loaded cocking plunger on the rear of the valve, inward to close the slide valve and cock the release, then engage the trigger with the spring lugs.

(g) Load the hopper with 15 lb. of dry, uncontaminated, grit (89-1).

CAUTION: DO NOT USE CLEANING MATERIAL WHICH DOES NOT CONFORM TO THE SPECIFICATION.

NOTE: (1) Some Operators may find that a smaller amount of grit will clean the compressor and give satisfactory power restoration. In this event, the hopper can be loaded with less cleaning material.

(2) If, using the soft blast cleaning procedure, the first attempt to restore engine performance is unsuccessful, only one more attempt by this method should be made.

(4) Operate the rig.

CAUTION: AN EXCESSIVE GRIT INGESTION RATE CAN BE HARMFUL TO THE COMPRESSOR AIRFLOW SURFACES. IT IS ESSENTIAL THAT THE ADJUSTMENT AND FLOW RATE DESCRIBED IN (3) (e) IS CHECKED AND CORRECTED TO ENSURE THAT A GRIT FLOW RATE OF 5 LB./MIN. WILL NOT BE EXCEEDED WHEN THE CONTROL VALVE IS OPENED.

(a) Start the engine as described in Chap.71-0, 'Adjustment/test', then run the engine at 13,000 r.p.m. and set the fuel datum to full DECrease.

(b) Pull the trigger release cord to open the hopper feed valve and release the 15 lb. of grit into the engine air intake; this should take 3 to 4 minutes at a constant flow rate of 5 lb./min. approximately.

(c) When ingestion is complete, and the hopper is empty, set the fuel datum to ambient conditions and close the throttle lever.

(d) Run the engine at idling for 5 minutes, then check that there is no excessive oil leakage from the engine breather.

(e) Stop the engine and examine the propeller, air intake casing and the visible surfaces of the first stage impeller for oil leaks.

(5) Remove the cleaning rig.

(6) Inspect the engine after cleaning the compressor, as follows:

(a) Remove and inspect the pressure oil filter element as described in Chap.72-8 and take any necessary action if contamination is found. If the filter is clear, wash it in clean kerosine and refit.

(b) If the fuel heater hot air gate valve was not removed prior to compressor cleaning, remove and inspect the valve for contamination and, if necessary, clean it; refit the valve and test it for correct functioning during the serviceability ground run as described in Chap.71-0, 'Adjustment/test'.

(c) Remove the fuel drain valve (71-2). Examine the valve for contamination and, if necessary, clean it; refit the valve and check it at the next engine run.

(7) Remove all blanks.

(a) Remove the blanks from the fuel flow control unit ram air pressure pipe and its connection on the air intake casing and reconnect the pipe.

(b) Remove the blank from the fuel flow control unit ram air pressure orifice in the air intake casing lower strut.

(c) Remove the blanks from the pressure supply pipe and its connection on No.2 compressor outlet elbow, reconnect the pipe, then tighten and lock the connector nut using 22 S.W.G. stainless steel wire (89-1).

(d) Remove the blanks from the compressor interstage casing hot air outlet and the outlet duct connection on the fireproof bulkhead; refit the hot air gate valve in accordance with the instructions detailed in Chap.75-1-1.

(8) Run the engine and carry out the serviceability ground run described in Chap.71-0, 'Adjustment/test', and check engine power; if the engine power is not acceptable only one more cleaning operation may be carried out. Re-interconnect the controls if necessary.

(9) Make a log book entry indicating that the compressor has been cleaned.

DESCRIPTION

GEAR TRAINS

The engine accessories are driven from the main rotating shaft assembly by gear train or drive shafts and bevel gears, as illustrated in fig. 1. The input drive from the starter motor to the starter engaging mechanism is transmitted through a shaft and bevel gear assembly.

Lower bevel gear assembly

The lower bevel gears, illustrated in fig. 2, are housed in a separate casting carried in the lower part of the air intake casing and are lubricated by pressure tappings from the reduction gear supply lines.

The input drive is from the reduction gear lower layshaft to a bevel drive shaft running parallel to the engine axis. The three output drives each consist of a bevel gear and shaft assembly; the port bevel gear drives the fuel pump, fitted on the port side of the intake casing, and the starboard bevel gear drives the propeller controller which is fitted on the starboard side of the intake casing. The shaft which carries the driving gear for both port and starboard bevels is splined at its forward end to the driving shaft of the gear-type oil pumps.

Accessory gear train

A train of spur gears, housed in a compartment at the forward end of the intermediate casing, provides the drive to the accessory gearbox (fig. 3).

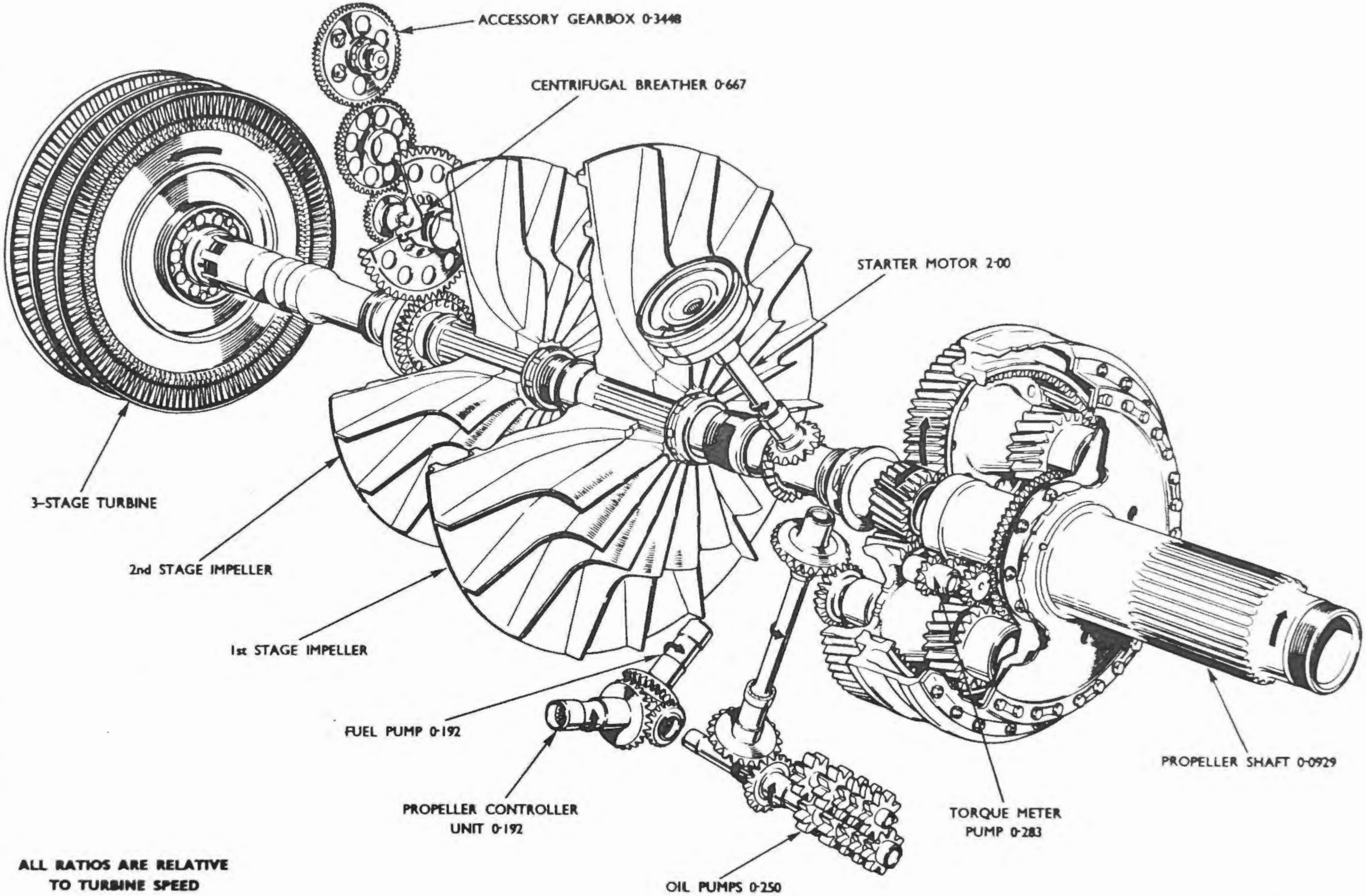
The train is driven by a gear wheel bolted to the front side of the second-stage impeller shaft coupling spline. Meshing with this driving gear and forming the first stage of the train is the front gear of the centrifugal breather assembly.

The front gear of the breather assembly carries an arrangement of vanes which apply a rotary motion to the breather air and the resulting centrifugal force separates from the air any oil droplets that are suspended in it. This gear also incorporates an integral shaft through which the drive is transmitted to the second gear of the breather assembly. The latter gear is splined to the rear end of the shaft and, in turn, drives the two remaining gears of the train.

The accessory gearbox is driven at a lower speed than that of the engine main shaft assembly; this reduction in driving speed is effected by the centrifugal breather gears, the front gear being of a larger diameter than the rear one, and the two remaining gears of the train.

The gear wheel forming the final stage of the gear train is splined to a shaft which has an integral four-bolt flange at its rear end. This flange protrudes from the gear train housing and, when the engine is installed, couples with a shaft extending rearward from the engine to transmit the drive to the accessory gearbox.

A metal guard, secured to the gear train housing, encloses the four-bolt flange and also the universal coupling of the transmission shaft.



ALL RATIOS ARE RELATIVE TO TURBINE SPEED

Fig. 1 Gear train diagram

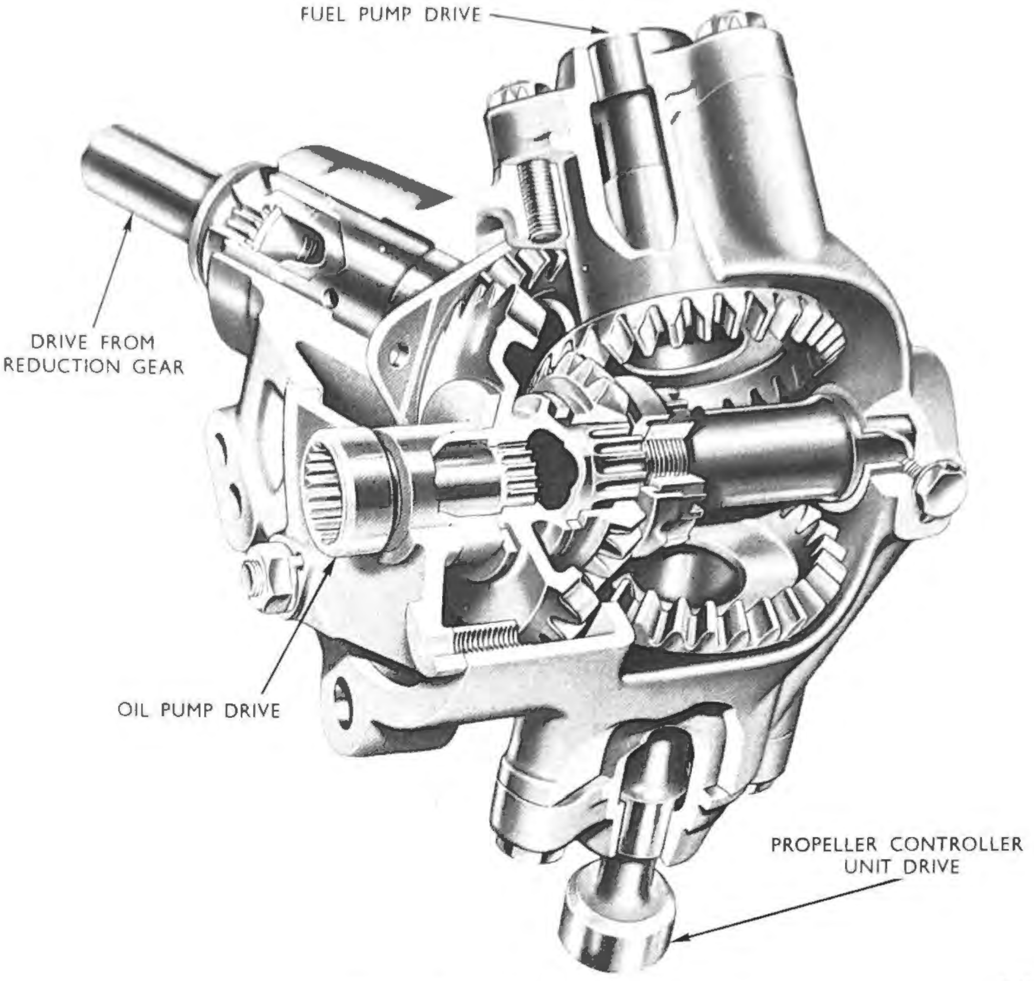


Fig. 2 Lower bevel gear drives

The plain bearings used throughout the train are lubricated by pressure oil fed into the hollow gearshaft through passages in the intermediate casing and gear train housing, as shown in 72-8 (fig. 5). Oil in the gearshafts flows outwards through drillings to lubricate the plain bearings.

The gear meshing points are lubricated by jets also fed through passages in the casing. After lubricating the bearings and meshing points, the oil is returned to scavenge through a drain point in the lower housing.

Starter assembly

The engine is ground started by transmitting torque from the externally fitted starter motor through a clutch coupling and an inclined shaft and bevel gear, illustrated in fig. 4, to the starter engaging mechanism on the engine main shaft assembly.

The starter clutch is of the spring-loaded multi-plate type and protects the whole starter assembly, of inclined shaft, bevel gears and starter mechanism, from excessive shock loading. The ratio between the driving bevel gear on the inclined shaft and the meshing gear on the engaging mechanism sleeve provides a speed reduction which allows the starter motor to develop full torque.

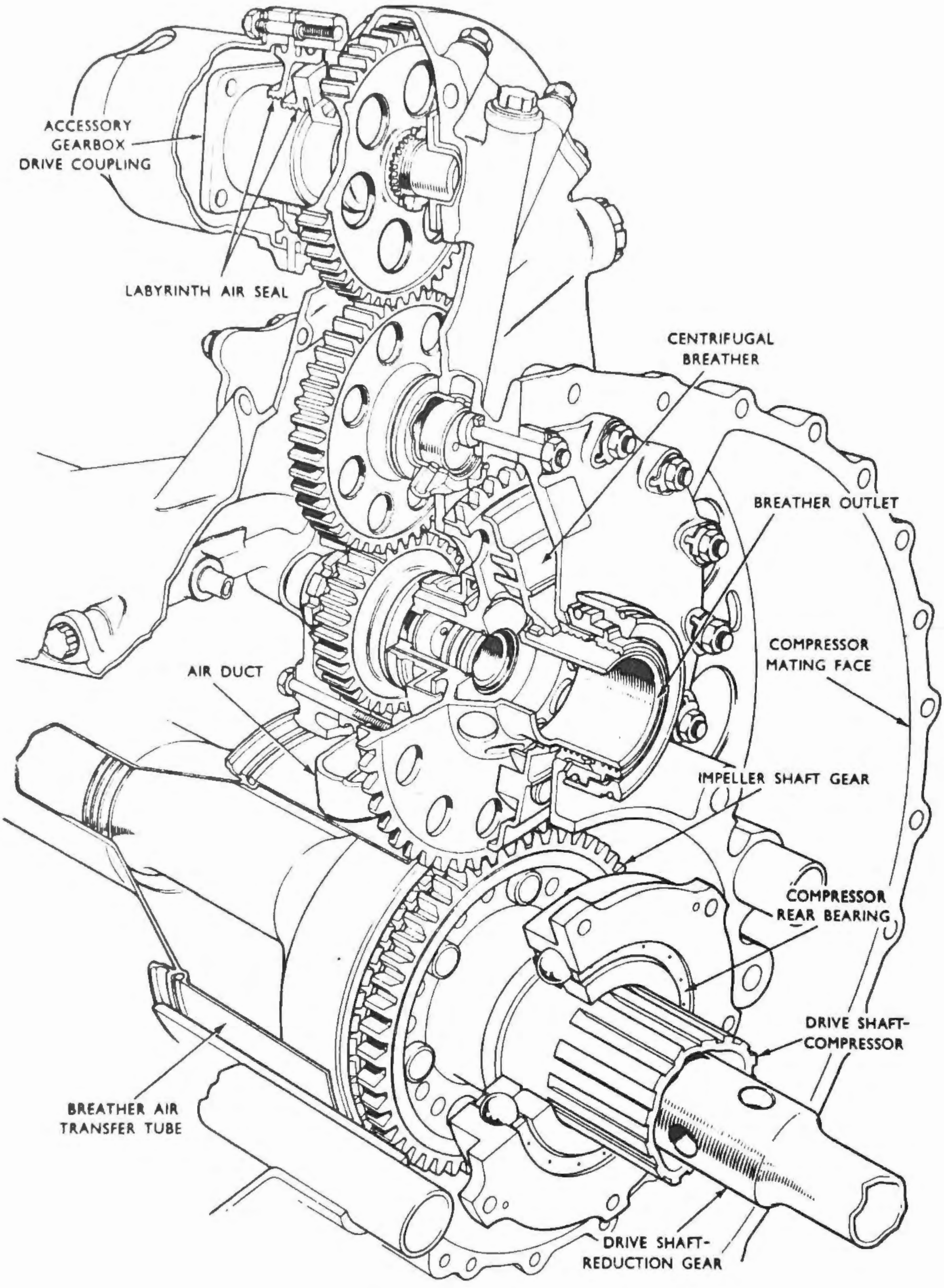


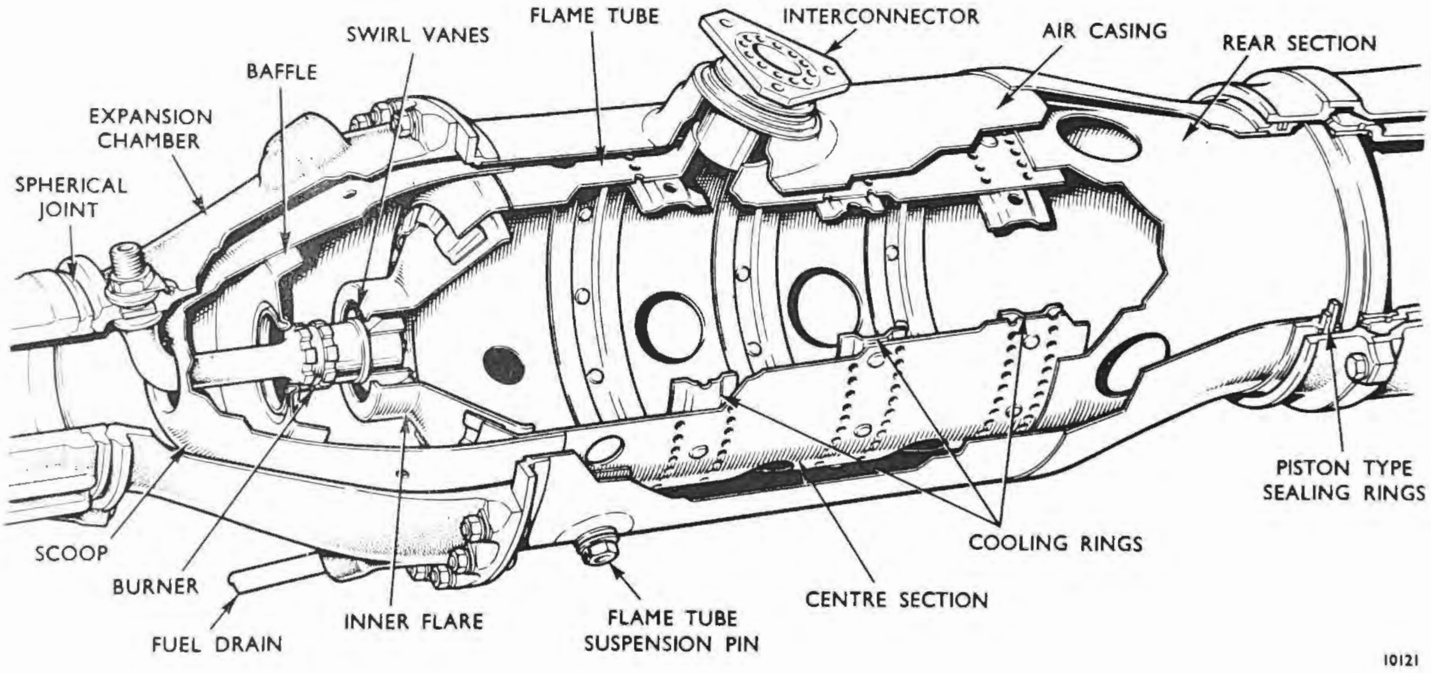
Fig. 3 Accessory gearbox drive

COMBUSTION SECTION - DESCRIPTION AND OPERATION

1. General

Air supplied from the compressor is delivered to the combustion chambers. A proportion of this air is mixed with a spray of highly atomized fuel from the burner in each combustion chamber flame tube to form a combustible mixture which is ignited and burned continuously, and the resultant high velocity gas flow discharged rearward through the turbine assembly. The remainder of the air is used to assist flame stabilization and cool the flame tube walls, and to dilute the hot gases to give an acceptable turbine entry temperature.

The seven combustion chambers are arranged around the intermediate casing, between the compressor and turbine, each chamber positioned at an angle of 7½ deg. from the engine axis to minimize the overall length of the engine. Viewed from the rear, the chambers are numbered anti-clockwise, No.1 being at the top on the right-hand side of the auxiliary (accessory) gearbox drive. High-energy igniter plugs are fitted to No.3 and No.7 combustion chambers.



Combustion chamber
Fig. 1

Each combustion chamber assembly (Fig.1) consists of a cast aluminium-alloy expansion chamber, bolted to a sheet-steel air casing within which is mounted a heat-resisting flame tube. A fuel burner (Chap.73), which directs a fine spray of fuel downstream into the flame tube, is incorporated in each combustion chamber assembly.

2. Description

A. Air casing and expansion chamber

Each air casing has two sleeved interconnector bosses, three flame tube locating pin bosses and, on No.1, 2, 5 and 6 air casings, a drain boss; all bosses are welded to the air casings. An additional boss, positioned in the same axial plane as the flame tube locating pin bosses, is incorporated on air casings to Mod.855 standard (Service Bulletin No. Da.72-39); this boss, which is normally blanked off, facilitates burner cleaning through a secondary hole in the flame tube.

Anti-tear straps, manufactured in steel and which are removable, are fitted around air casings to retard the progression of cracks which may originate at the soleplates of the suspension pin bosses and/or the drain boss. The straps, which surround the forward part of all air casings to pre-Mod.553 standard only, locate over the flame tube suspension pin bosses. If Mod.855 is embodied, the straps are to Mod. 1021 (Service Bulletin No. Da72-106) standard to accommodate the burner cleaning boss; if the air casing is pre-Mod.553 and pre-Mod.855, the straps are to Mod.612 standard.

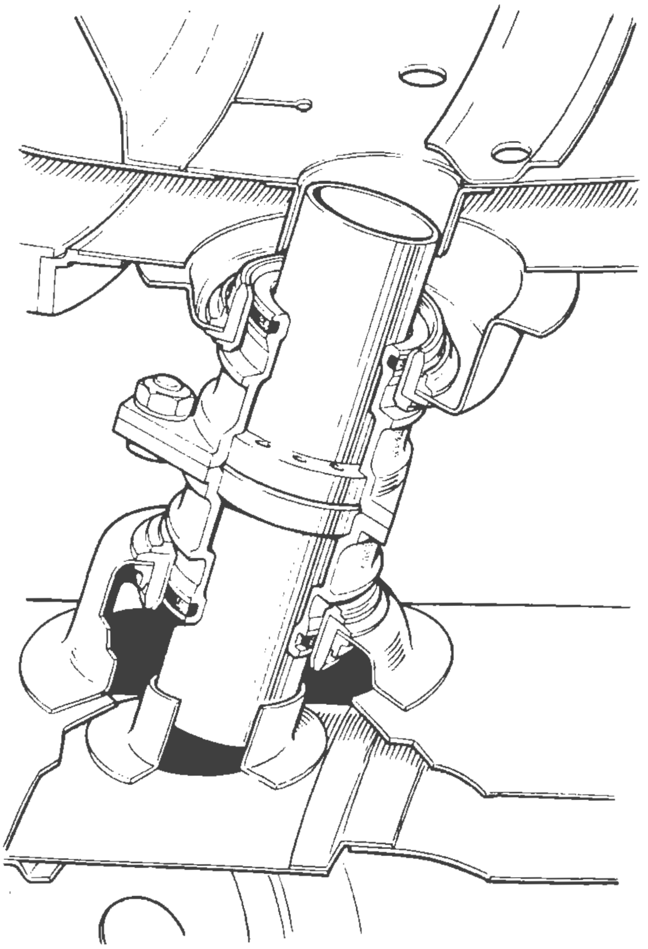
Anti-tear straps introduced by Mod.1442 (Service Bulletin No. Da72-289) surround that part of the air casing on which the drain boss is mounted; the straps, which are located by the drain boss, are fitted to No.1 and 5 combustion chambers and are applicable only to Mod.553 and pre-Mod.1410 (Service Bulletin No. Da72-304) air casings.

To allow for expansion when the engine is running, the discharge end of each combustion chamber is free to slide in its nozzle box location, gas leakage being prevented by piston-ring type seals. Each casing is protected against corrosion, internally and externally, by an aluminized coating.

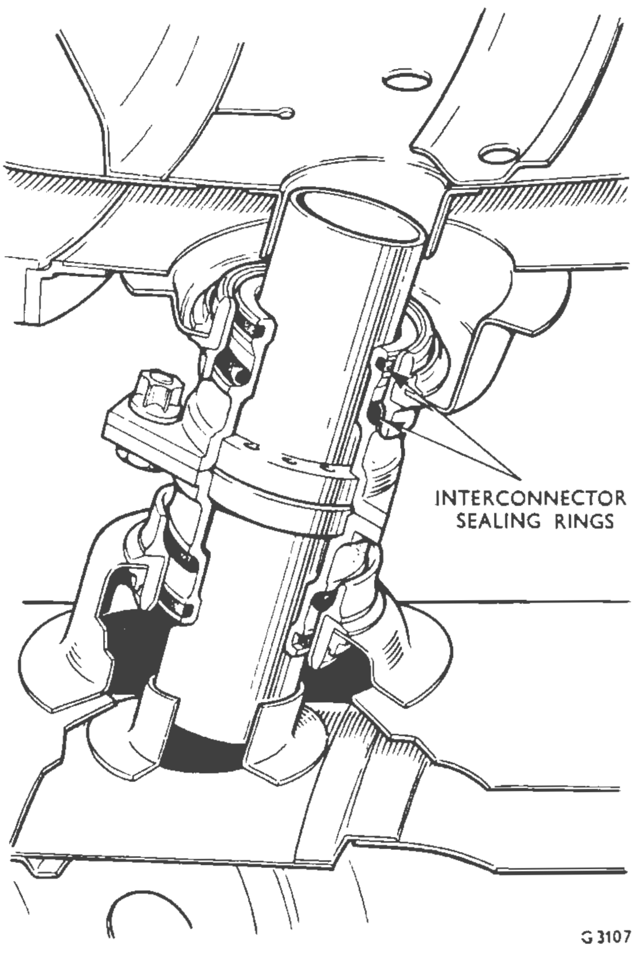
The cast expansion chamber, through which the compressor efflux enters the combustion chamber, is bolted to the air casing and connected to the compressor outlet elbow by two swivel-link bolts. No.3 and 4 expansion chambers carry drain bosses, and No.5 expansion chamber embodies the fuel drain valve mounting platform. A spherical-seating spigoted sealing ring (manufactured in case-hardened nickel chrome steel) is positioned between the compressor outlet elbow and the expansion chamber. On engines which feature Mod.1173 (Service Bulletin No.Da72-178) the sealing rings are deeply anodized to minimize wear.

B. Interconnectors

To ensure even pressure distribution and allow the flame to spread to all chambers during the starting cycle, the combustion chambers are interconnected. The interconnectors consist of two concentric tubes, the inner of which forms the hot gas passage between adjacent flame tubes. The annular space between the interconnector tubes forms a passage for the flow of cooling air from the air casing. The double tube assembly in each chamber is connected by a flanged and bolted joint; a rubber sealing ring positioned between the outer tube and its liner in each air casing interconnector boss prevents leakage of cooling air and permits movement to allow for radial expansion during engine operation. On engines which feature Mod.1140 (Service Bulletin No. Da72-142) improved sealing of the interconnectors is obtained by fitting an additional seal (Fig.3) between the liner in the air casing and the flange of the interconnector outer tube; on engines which embody Mod.1147 (Service Bulletin No. Da72-205) additional sealing efficiency is gained by fitting an increased diameter sealing ring to replace the seal introduced by Mod.1140.



Interconnector - single sealing
Fig.2

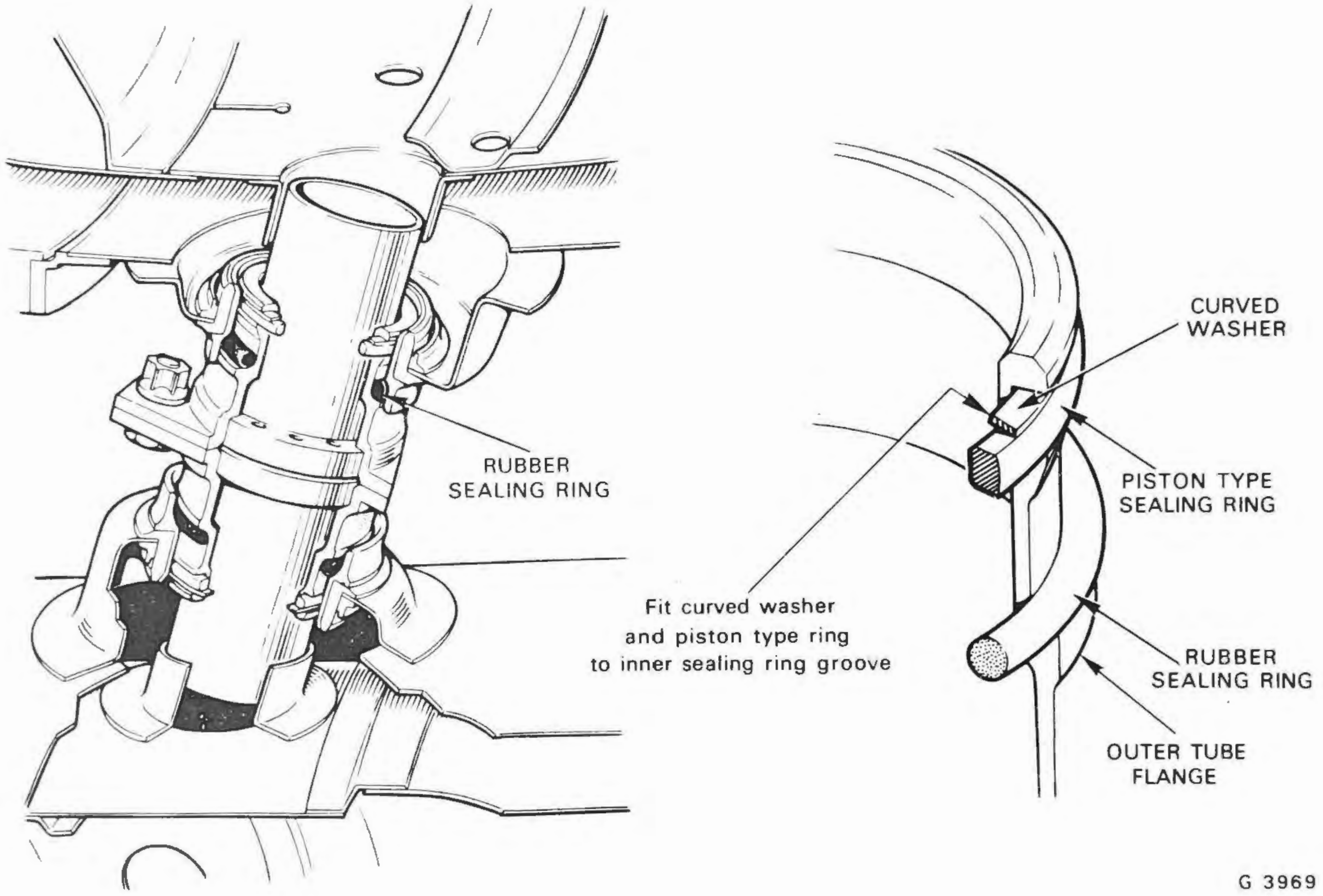


Interconnector - double sealing
Fig.3

To minimize gas leakage past the interconnectors and improve engine efficiency, Mod.1473 (S.B. Da.72-305) introduces a cast iron piston type sealing ring (Fig.3A) to replace the inner rubber sealing ring on interconnectors to Mod.1147 standard.

To prevent spinning of the piston ring and consequent wear, a cadmium plated curved steel washer is located in the sealing ring groove to provide a spring load on the ring.

Outer rubber sealing rings are retained to absorb vibration and prevent rotation of the interconnector. To ensure effective sealing, rubber sealing rings to Mod.1451 standard (S.B. Da-Misc-59) must be used in conjunction with the piston ring and steel washer.



Interconnector seal arrangement - Mod.1473
Fig.3A

C. Fuel drains

Any fuel which may accumulate in the combustion chambers when the engine is shut down, or after an abortive start, escapes via the drainage system to the drain valve (Chapter 71) situated on No.5 expansion chamber.

D. Flame tubes

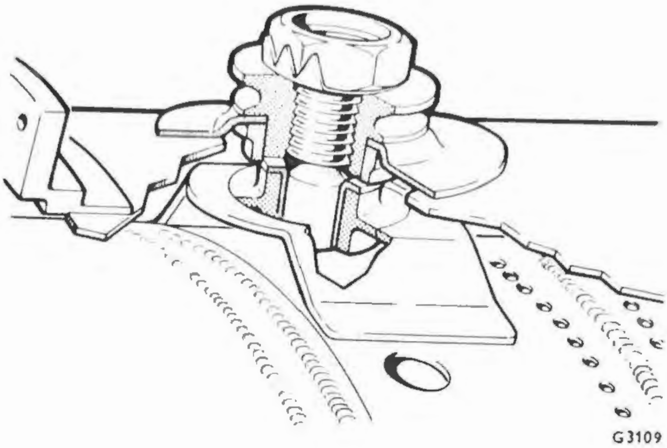
Each flame tube is mounted centrally within its air casing on three locating pins, with its discharge end positioned in the discharge nozzle in the nozzle box. To prevent gas leakage and allow for longitudinal expansion when the engine is running, the flame tube incorporates a sealing ring in the form of a machined land at its discharge end which allows the tube to slide in its nozzle location.

The flame tubes (Fig.1) are manufactured from Nimonic steel to withstand the high temperatures produced by the burning air/fuel mixture and a series of holes and cooling rings is incorporated to obtain improved combustion and cooling efficiency. Construction of the tube is in three welded sections - a nose section, a parallel centre section and a rear section. The nose section, or inlet scoop, carries a baffle and an inner and outer flare; the inner flare houses the swirl vanes and the vanes locate the burner head. The centre section carries the three cooling rings, the welded interconnector bores and the bridge-type platforms which locate the flame tube suspension pins. The rear conical section incorporates a sealing ring which is welded to the discharge end. The rear sealing rings on flame tubes to Mod.838 standard (Service Bulletin No.Da72-9) have a stellite deposit to reduce wear and fretting and on flame tubes to Mod.1138 (Service Bulletin No.Da72-151) standard the rear sealing ring is re-designed to incorporate a number of holes through which a small quantity of cooling air passes to reduce the temperature of the discharge nozzles and nozzle box.

On flame tubes to Mod.614 standard, burner cleaning can be accomplished in situ after removal of the appropriate outer suspension pin.

To improve combustion efficiency Mod.1138 introduced a flame tube with plunged secondary holes and a single tertiary hole in the rear section; it is a requirement on the embodiment of Mod.1138 that the engine controls be re-set to increase the idling fuel flow.

To prevent overheating of the air casings Mod.1394 (Service Bulletin No. Da72-272) introduces flame tubes with no tertiary holes in the rear section and a centre section in which the four rear tertiary holes are plunged.



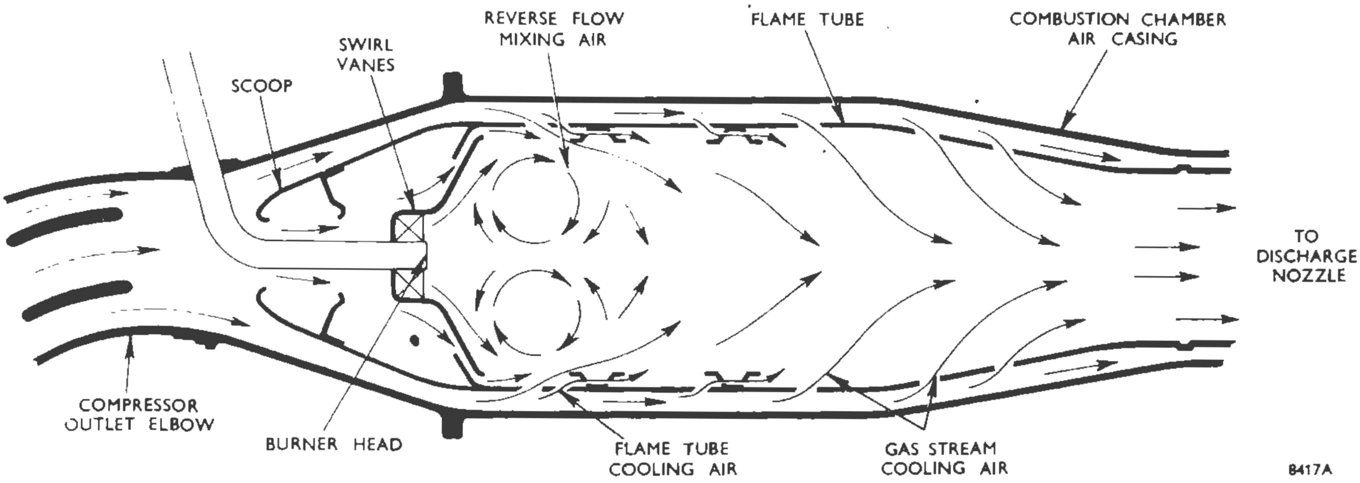
Typical flame tube locating pin
Fig.4

3. Operation

An atomized spray of fuel from the burner is injected into the flame tube to mix with the air flow from the compressor; sparks from the high-energy igniters in No.3 and 7 flame tubes initiate combustion and the resultant flame spreads into the adjacent flame tubes through the interconnectors. To minimize the formation of carbon, a flow of air is directed across the face of the burner through an annular shroud ring around the burner head.

Approximately 20 per cent of the air flow entering the combustion chambers passes into the primary zone of the flame tube through the inlet scoop and swirl vanes; the vanes create an area of low pressure in the primary zone and the turbulence necessary to break up the fuel spray. The flow of air through the flare combines with that through the swirl vanes to create a vortex which assists combustion by mixing the fuel and air, and controls the length of the flame (Fig.5).

The air which passes outside the scoop flows through the annular space between the flame tube and its air casing to insulate the casing from the heat of combustion and cool the flame tube. A small proportion of this air flow is directed to the discharge nozzles for cooling purposes, whilst the remainder is progressively introduced, through secondary and tertiary holes and through three cooling rings positioned at intervals within the tube, into the flame tube; two bands of small diameter holes are situated adjacent the cooling ring lips, air being admitted through the upstream band to flow over the rings and reduce their temperature, whilst air admitted through the downstream holes flows along the inner wall of the tube to prevent the hot gases impinging on the wall. A proportion of the air admitted through the secondary and tertiary holes helps to maintain the combustion process, while the remainder is used to cool the products of combustion i.e., to reduce the temperature of the gas stream from approximately 2000 deg.C., to approximately 850 deg.C. - a temperature acceptable to the turbine.



Flame stabilization and air flow diagram
Fig. 5

COMBUSTION SECTION - MAINTENANCE PRACTICES

NOTE: Combustion chambers may have to be removed to remedy gas leaks, renew the flame tubes, air casings or fuel burners, or facilitate examination of the turbine and compressor assemblies if damage is suspected. Before any removal see '4. Adjustment/test'.

1. Removal/Installation - Combustion chambers

A. Remove the combustion chambers

(1) Remove the auxiliary (accessory) drive shaft cover to gain access to No.1 and No.2 combustion chambers.

WARNING: THE ELECTRICAL ENERGY WHICH MAY BE STORED IN THE CAPACITORS OF THE HIGH-ENERGY IGNITION UNITS IS POTENTIALLY LETHAL. BEFORE HANDLING THE UNIT, PLUG OR H.T. LEADS, DISCONNECT THE L.T. SUPPLY AND WAIT FOR AT LEAST 1 MINUTE TO ALLOW THE STORED ENERGY TO DISSIPATE.

(2) Observe the WARNING, then disconnect the igniter plug H.T. leads at No.3 and No.7 combustion chambers.

(3) Remove the fuel drain valve assembly (Chapter 71) to gain access to No.5 combustion chamber.

NOTE: The following procedure is common for the removal of all combustion chambers. Viewed from the rear, the chambers are numbered anti-clockwise, No.1 being at the top on the right-hand side of the auxiliary gearbox drive. The recommended sequence of removal is No.1, 7, 6, 5, 4, 3, 2.

(4) Sever the lockwire and disconnect the flexible pipes from the burners.

(5) Engage the tool HW.27065 to prevent the interconnectors from turning, then remove the nuts, tabwashers and bolts which secure each pair of interconnectors. On engines which feature Mod.1242 (Service Bulletin No.Da72-203) the bolts are secured by self-locking nuts which are removed by using tool KU.13053 in conjunction with HW.27065.

(6) Remove the split pins and unscrew the castellated nuts from the combustion chamber link bolts securing each combustion chamber to its compressor outlet elbow. On engines which feature Mod.1350 or Mod.1591 (Service Bulletin No.Da72-243 and Da72-368 respectively) use the socket UT.180 to unscrew the self-locking nuts from the link bolts.

(7) Push the combustion chamber as far as possible towards the nozzle box and withdraw the spherical sealing ring from between the chamber and compressor outlet elbow (fig.201).

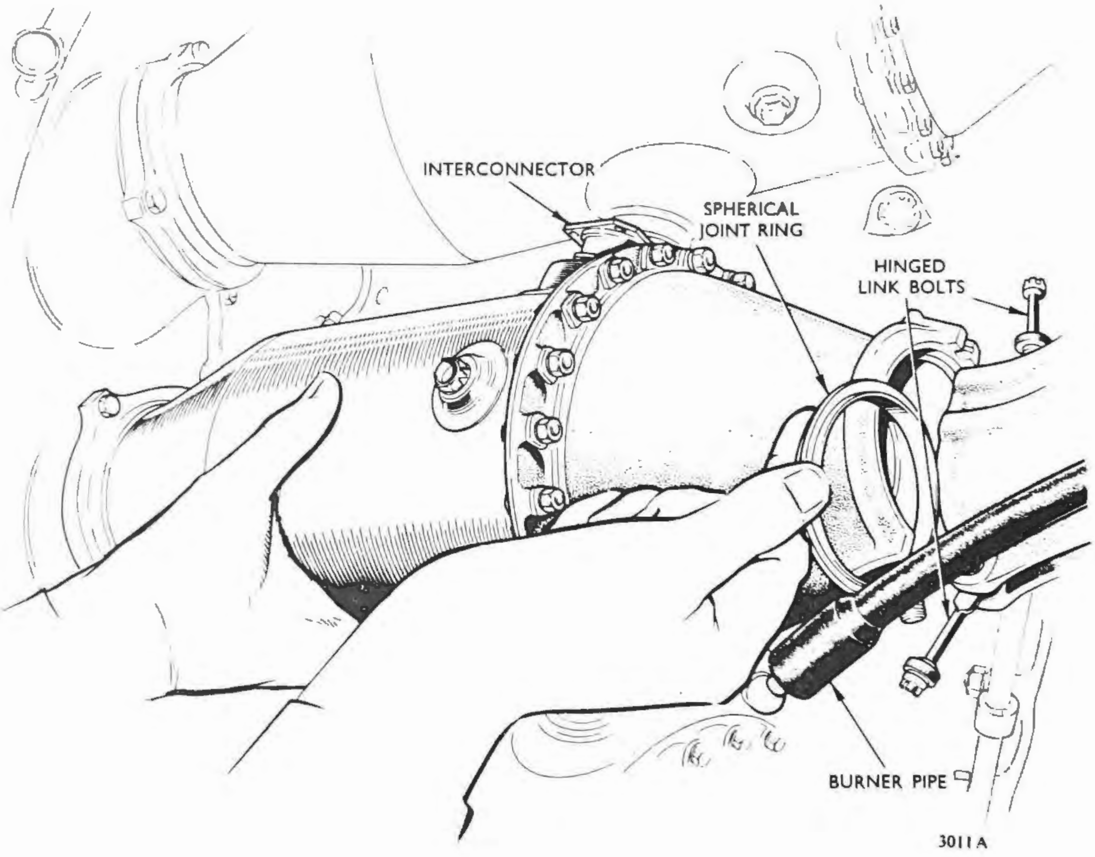
Combustion section - Maintenance practices (cont.)

(8) If Mod.1632 is embodied, using a suitable wooden scraper, remove the compound from the drain tubes and bosses.

(9) Withdraw the combustion chamber by pulling it outwards and forward, simultaneously releasing the fuel drain tube.

(10) Remove the piston ring type seals from the groove at the rear of the combustion chamber and place them, with the spherical sealing ring, adjacent to the removed combustion chamber.

(11) If Mod.1632 is embodied, using a suitable wooden scraper, remove all traces of compound from the drain tubes and bosses.



Combustion chamber - Removal details
Fig.201

(12) Fit suitable blanks to all pipe ends and apertures, particularly those giving access to the interior of the engine, which are uncovered as work progresses.

(13) If the combustion chambers are not to receive immediate attention, fit suitable blanks to each end of the chambers and to all burner, interconnector, igniter and drain tube apertures.

B. Install the combustion chambers

(1) Before installing combustion chambers, ensure, if applicable, that the identification on the burner and expansion chamber correspond (see Chapter 73).

(2) Visually examine the spherical joint ring and the split sealing rings, and their appropriate mating faces on the combustion chamber for damage, frettage and wear, particularly if the chamber shows evidence of gas blows at these points. Clean up or renew the rings as necessary.

(3) If renewing the spherical joint ring it is important to check that the correct size replacement ring is used. Two sizes of ring may be encountered in service:

Standard size - Part No.RK.13296
0.040 in. o/size - Part No.RK.16732

NOTE: The latter joint ring, specified when Dart Repair Scheme 20, Part B or Part C (Overhaul Manual) has been embodied, can be identified by the four flats on the periphery; its mating combustion chamber is engraved D.R.S.20B or D.R.S.20C, near the positional markings on the expansion chamber. The appropriate size spherical joint ring will be supplied with all replacement chamber assemblies.

(4) Fit new interconnector sealing rings

(a) Pre-Mod.1473: if rubber sealing rings to either Mod.1140 or Mod.1147 standard are fitted, lubricate the rings with kerosine to Spec. D.Eng.R.D.2494 then fit one ring adjacent to the flange of the outer tube so that, when the interconnector is fitted, the ring will be trapped between the liner on the air casing interconnector boss and the flange of the outer tube; fit the other ring to the sealing ring groove in the outer tube.

(b) Mod.1473: if Mod.1473 is incorporated, fit a rubber sealing ring (to Mod.1451 standard) adjacent to the flange as described in (a); fit a piston type sealing ring and a curved washer to the sealing ring groove (refer to sealing ring arrangement, Fig.3A) and ensure that the split in the washer is diametrically opposite to the gap in the ring. Ensure that the curved washer has not sprung as it may not provide positive loading when the interconnector is fitted; use light finger pressure to restore a sprung washer to correct shape and position. Check that both the washer and the ring are free to rotate in the interconnector sealing groove.

(5) Fit the interconnectors to the combustion chambers, ensuring that the longer interconnector is inserted into the boss bearer to the expansion chamber/air casing joint flange. If interconnectors to Mod.1473 standard are being fitted take care to ensure that the curved washer does not distort and slip inside the piston ring thus preventing correct assembly.

NOTE: On pre-Mod.1147 engines the longer interconnector incorporates a trap for the securing bolt heads; on Mod.1147 engines, this trap is deleted and the bolts are entered from the shorter interconnector.

(6) Fit the two piston ring type seals, with the gaps diametrically opposed, to the groove in the rear end of the air casing. Smear the rings with grease specified in Chapter 89.

(7) Apply a thin film of jointing compound (Chapter 89) to the mating faces of the spherical sealing ring, the expansion chamber and the compressor outlet elbow.

(8) Pre-Mod.1632

(a) Fit a new rubber sealing ring to each end of each drain tube and lubricate seals with kerosine to Spec. D.Eng.R.D.2494.

NOTE: Mod.546 and Mod.840 (Service Bulletin No.Da.Misc.2) engines have rubber sealing rings fitted to the drain tubes. Mod.1399 (Service Bulletin No.Da.72-269) introduces new rubber sealing rings to replace existing seals. It is essential that if any part of Mod.583 is embodied (aluminium alloy drain tubes), the drain tubes must be fitted with rubber sealing rings to either Mod.840 or Mod.1399 standard. Mod.1399 sealing rings must be fitted in sets.

(9) Mod.1632

(a) Fit a new rubber sealing ring to each end of each drain tube.

(b) Apply the primer D.C.4094, MS.2402 if using Silastic RTV731 or use Silcoset O.P.1 if using Silcoset 151, 152 or RTV106 to the areas to be coated with compound; refer to Fig.201A and Chapter 89-1.

(c) Apply Silastic RTV731, Silcoset 151, 152 or RTV106 to the areas shown in Fig.201A then, using the same compound, lightly smear the sealing rings; refer to Chapter 89-1.

(10) Prepare the combustion chambers for installation on the engine. The combustion chambers are numbered anti-clockwise looking from the rear, No.1 being at the right-hand side of the auxiliary (accessory) gearbox drive.

(11) The installation of each combustion chamber to the engine is common and is as follows:

(a) Smear the larger bore of each nozzle, in the nozzle box, with graphite grease (Chapter 89).

(b) Fit No.1 combustion chamber first by inserting the rear end into its respective nozzle in the nozzle box. Push the combustion chamber as far as possible towards the nozzle box, then insert the spherical sealing ring between the expansion chamber and its outlet elbow; position the sealing ring with the spherical face towards the expansion chamber. Pull the combustion chamber forwards (away from the nozzle box) and locate it on the spherical sealing ring.

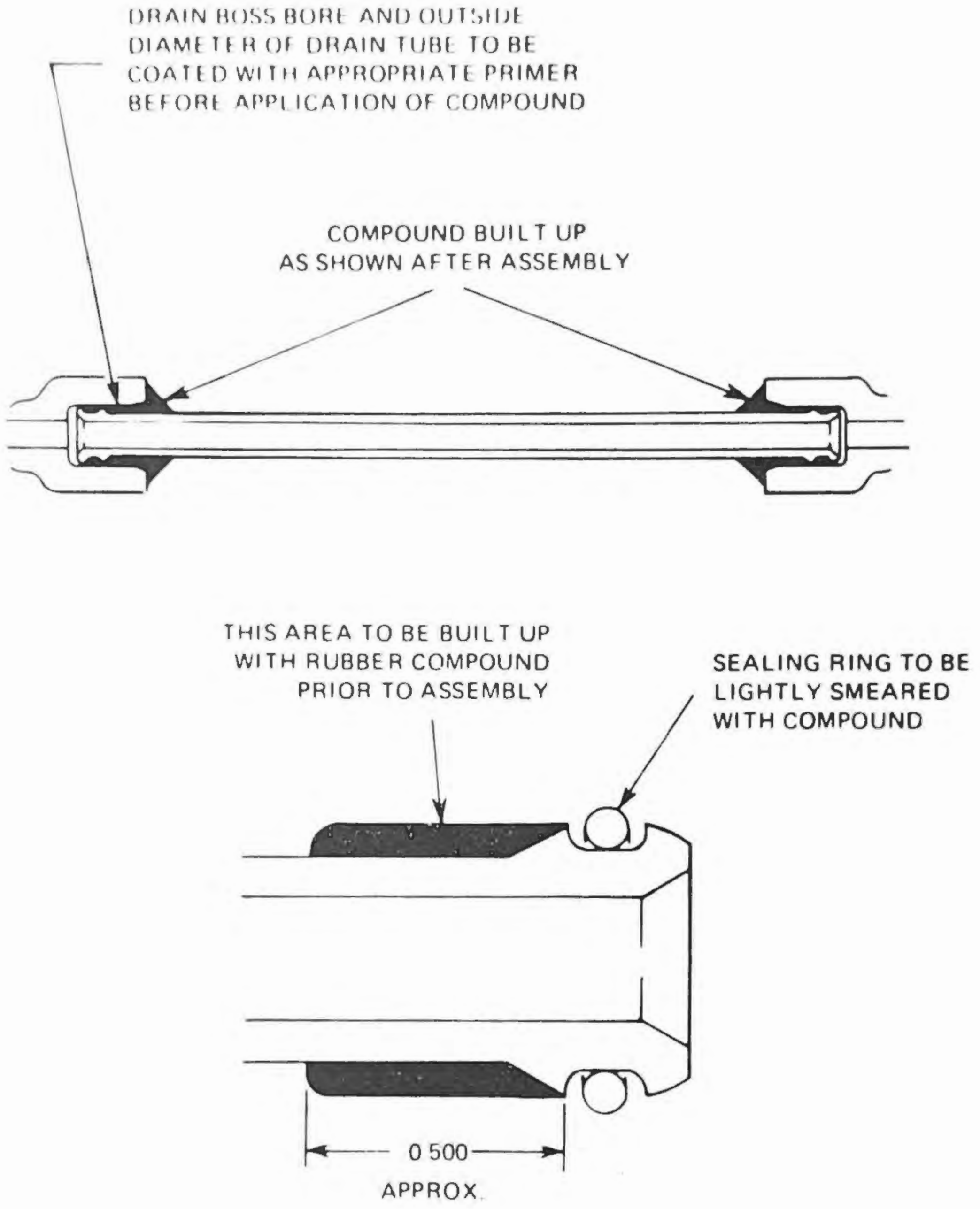
(c) Insert the end of one of the two intermediate length drain tubes into the boss on the inward facing part of No.1 air casing, then install No.2 combustion chamber as previously described, entering the free end of the drain tube into its bore in the No.2 air casing.

(d) Fit the remaining combustion chambers and drain tubes to the engine.

NOTE: Fit two of the three longest drain tubes, one between No.3 and 4 combustion chambers and another between No.4 and 5 combustion chambers. The other intermediate length drain tube fits between No.5 and 6 combustion chambers.

(e) Using a suitable dispenser, apply the compound, previously used in (9), (c), between the drain tubes and drain bosses simultaneously rotating the tubes; refer to Fig.201A.

(f) Remove surplus compound from the assembly and allow to air cure for 24 hours.


DRAIN BOSS BORE AND OUTSIDE DIAMETER OF DRAIN TUBE TO BE COATED WITH APPROPRIATE PRIMER BEFORE APPLICATION OF COMPOUND
COMPOUND BUILT UP AS SHOWN AFTER ASSEMBLY
THIS AREA TO BE BUILT UP WITH RUBBER COMPOUND PRIOR TO ASSEMBLY
SEALING RING TO BE LIGHTLY SMEARED WITH COMPOUND
0 500
APPROX.

ALL DIMENSIONS IN INCHES

TYPICAL ENLARGED VIEW OF TUBE END

G 7541

Section through typical drain tube
showing application of compound
Fig.201A

(g) Swing the hinged link bolts, (outlet elbow to combustion chamber) into position and temporarily 'nip' the securing nuts to ensure correct seating of the sealing ring.

(h) Check the clearance between the compressor outlet elbows and the expansion chamber link bolt lugs. If the clearance is less than 0.020 in., remove the combustion chamber(s) then, remove sufficient material from the expansion chamber link bolt lug(s) to obtain the required clearance. Refit the combustion chamber(s) as previously instructed.

(j) On pre-Mod.1242 engines secure each pair of interconnectors together with three bolts, tabwashers and nuts; on pre-Mod.1147 engines, insert the bolts through the flange of the interconnector which incorporates a trap for the bolt heads. Use the tool HW.27065 to hold the interconnectors whilst tightening the nuts. After tightening the nuts, bend up the tabwashers. On Mod.1242 engines the bolts are secured by self-locking nuts; tighten the nuts using tool KU.13053 in conjunction with HW.27065. On Mod.1147 engines insert the bolts through the flange of the short interconnector so that the bolt heads bear against this flange, then secure the interconnectors with the bolts and self-locking nuts.

NOTE: Mod.1147 must be fitted in conjunction with Mod.1242.

(k) Release the nuts on the combustion chamber link-bolts then, ensure correct seating of the combustion chamber to outlet elbow sealing ring. Tighten the link bolt nuts using tool KU.12923 or UT 180 as follows:

(i) Pre-Mod.829 engines - tighten nuts until nipped, then continue by two castellations and if necessary, on to next split pin hole.

(ii) Mod.829 engines - tighten nuts until nipped then, torque tighten to 25 lb.in. Slacken off to nearest split pin position

(iii) Mod.1350 and Mod. 1591 engines - tighten nuts until nipped then, torque tighten to 30 lb.in.

NOTE: 1. On Mod.1350 engines each link bolt is secured with a self-locking nut, spigoted washer and plain washer. On Mod.1591 engines each link bolt is secured with a self-locking nut and increased thickness spigoted washer only.

2. Ensure that correct 'IN-BUILT (OR RUN-DOWN) TORQUE' between self-locking nut and link bolt is obtained as specified in Chapter 89-3, Page 11, Table 7, Thread size 10 UN.

(m) Check that the sealing ring is correctly seated. If the sealing ring is not correctly seated, repeat (k) and (m).

(n) Check that the clearance between the compressor outlet elbows and the expansion chamber link bolt lugs is as specified in (h). If the clearance is not as specified, remove the combustion chamber(s) and repeat (h) to (n).

(o) Fit the drain valve assembly to No.5 chamber (Chapter 71).

(p) Re-connect the burner flexible pipes; torque tighten the union nuts (Chapter 89) then wire-lock using stainless steel lockwire (Chapter 89).

(q) Fit the auxiliary (accessory) drive shaft cover.

(r) Fit the high tension igniter leads.

(s) On completion of the first ground run, inspect the engine for security and gas leaks and the burner pipes for fuel leakage.

2. Removal/Installation - Anti-tear straps

NOTE: All pre-Mod.553 air casings are fitted with removable anti-tear straps to either Mod.612 or if Mod.855 (S.B.No.Da72-39) is embodied, to Mod.1021 standard (S.B.No.Da72-106). The straps surround the forward part of the casing and are located over the flame tube suspension pin bosses.

Anti-tear straps which fit around the drain connectors of No.1 and 5 air casings only are introduced by Mod.1442 (S.B.No.Da72-289) to pre-Mod.1410 air casings.

A. Remove the anti-tear strap

(1) Remove the anti-tear strap (Mod.612 and 1021 types, Fig.202):

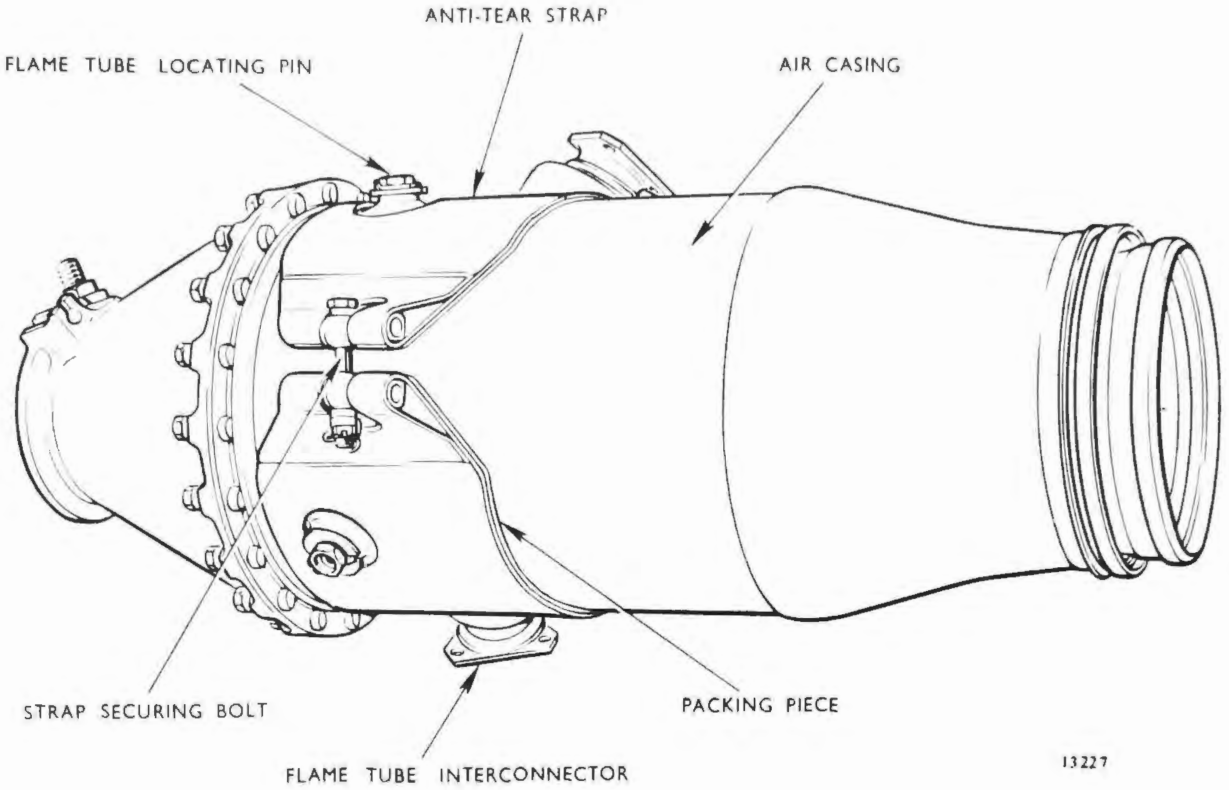
(a) Remove the combustion chamber as described in 1.A.

(b) Remove the split pin from the castellated nut on the strap securing bolt.

(c) Remove the nut, adjusting washers, bolt and two spherical washers.

(d) Remove the interconnectors.

(e) Ease the anti-tear strap open and remove the strap and packing piece from the air casing.



Anti-tear strap - Removal details
Fig.202

(2) Remove the anti-tear strap (Mod.1442 type, fig.203)

(a) Remove No.1 and 5 combustion chambers as described in 1.A.

(b) Unscrew the 2 worm drive type clips then remove the anti-tear strap and the asbestos anti-frettage packing strip.

B. Install the anti-tear strap

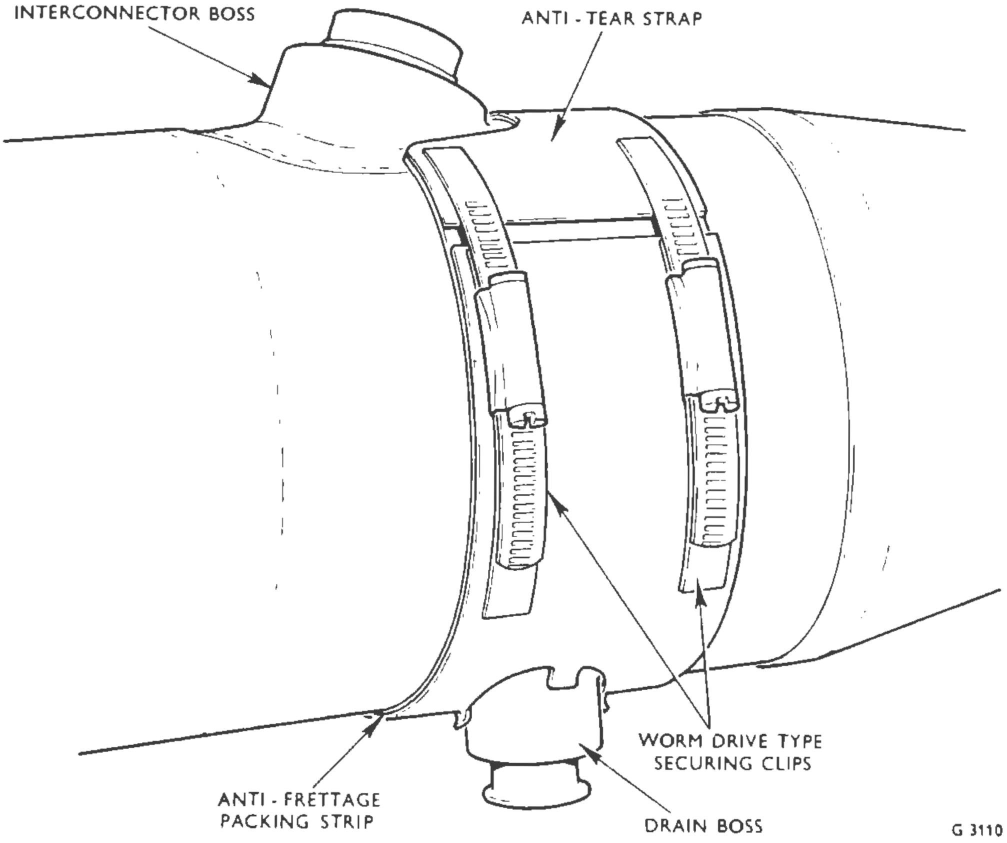
(1) Install the anti-tear strap (Mod.612 and 1021, fig.202)

(a) Ensure that the anti-tear strap and the packing piece are free from damage, cracking or deterioration.

(b) Fit the strap and packing piece to the air casing, locating them over the flame tube locating pin bosses.

(c) Fit a spherical washer to the securing bolt (concave face away from the bolt head) and slide the bolt into the holes in the strap stop-pins.

(d) Fit the second spherical washer, the required adjusting washers from the range provided and the castellated nut. Torque tighten the nut to the specified load (Chap.89) and secure with a split pin.



Anti-tear strap - Removal details
Fig.203

(2) Install the anti-tear strap (Mod.1442 type, fig.203:)

(a) Ensure that the anti-tear strap and the packing strip are free from damage, cracking or deterioration.

(b) Fit the strap and packing strip to the appropriate air casing, locating the cut-outs over the drain boss soleplate.

(c) Tighten the securing clips evenly ensuring that fouling does not occur between the strap and soleplate.

(d) Replace the combustion chambers (1.B.)

(e) On completion of the first ground run, check the anti-tear straps for security.

3. Removal/Installation - Flame tubes

NOTE: 1. Flame tube replacement is normally covered by changing the complete combustion chamber assembly, but before any removal see 4. Adjustment/test.

2. If a set of combustion chambers is removed from an engine and is to be fitted with a full replacement set of flame tubes, it is recommended that individual flame tubes of a set are to the same modification standard.

3. Details of flame tube replacement must be entered in the engine log book.

A. Remove flame tubes

(1) Remove the combustion chambers from the engine as described in 1.A.

(2) Remove the igniter plugs from No.3 and 7 combustion chambers.

(3) Remove the nuts and bolts securing the expansion chamber to the air casing, ensuring that each casing is alignment marked to facilitate replacement.

(4) Remove the expansion chamber from the air casing.

(5) Withdraw the two interconnectors.

(6) Remove the anti-tear straps as described in 2.A (1) and/or (2).

(7) Remove the three flame tube locating pins.

CAUTION: AVOID DAMAGE TO THE COMBUSTION CHAMBER WHEN UNLOCKING THE LOCATING PIN TAB WASHERS.

(8) Withdraw the flame tube from the air casing.

B. Replacement of locating pin liners

(1) Using extractor MST.284, or any suitable extractor, remove the worn liner from the flame tube.

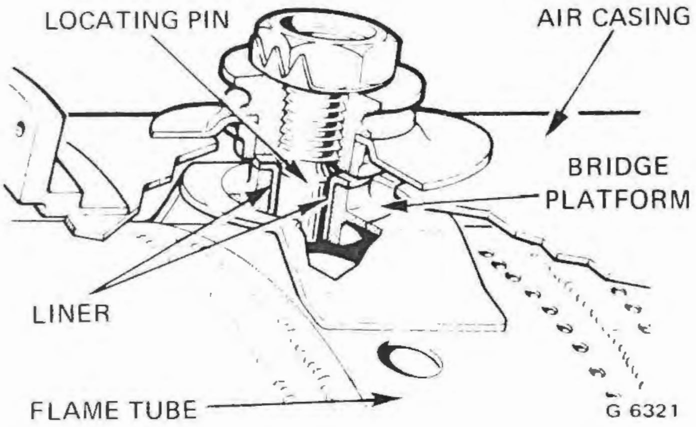
(2) Ensure that there is an interference fit between the new liner and the bridge platform boss; reject the flame tube if an interference fit with a replacement liner cannot be obtained.

(3) Using the freezing plug MST.285, freeze the new liner in liquid nitrogen until agitation ceases.

(4) Support the platform boss from the underside to prevent collapse of the bridge platform when fitting the new liner.

(5) Tap the liner lightly into position until the flange is seated squarely on the boss face.

NOTE: Freezing of the new liner prior to fitting may not be necessary in cases where there is little interference between the liner and the bridge platform boss.



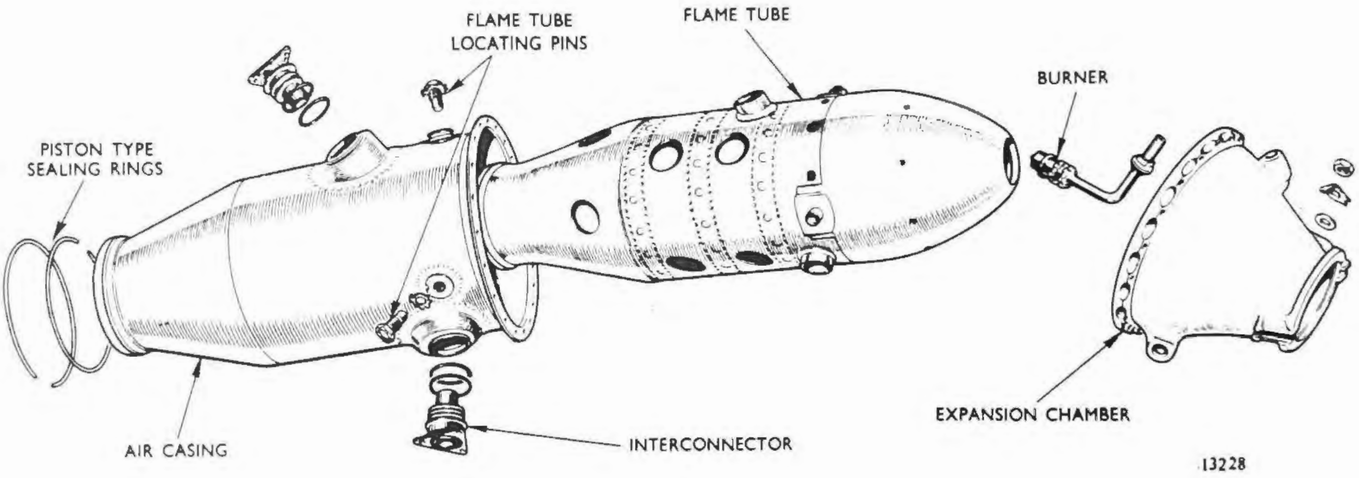
Typical flame tube suspension features
Fig.203A

C. Install the flame tubes

(1) Stand the air casing on a bench and lower the flame tube into position, ensuring that the interconnector bores and locating pin bosses are in line.

NOTE: Mod.855 air casings are each fitted with a burner cleaning boss which is normally blanked; No.3 and 7 flame tubes and expansion chambers each have an extra orifice to accommodate the igniter plugs.

(2) Fit tabwashers to the three locating pins and screw the pins into the bosses in the air casing, ensuring that the plain section of each pin locates in its appropriate bore in the flame tube. Tighten the pins to the torque loading specified in Chap.89.



Combustion chamber components
Fig.204

(3) Check the interconnector bores of all flame tubes and air casings for concentricity.

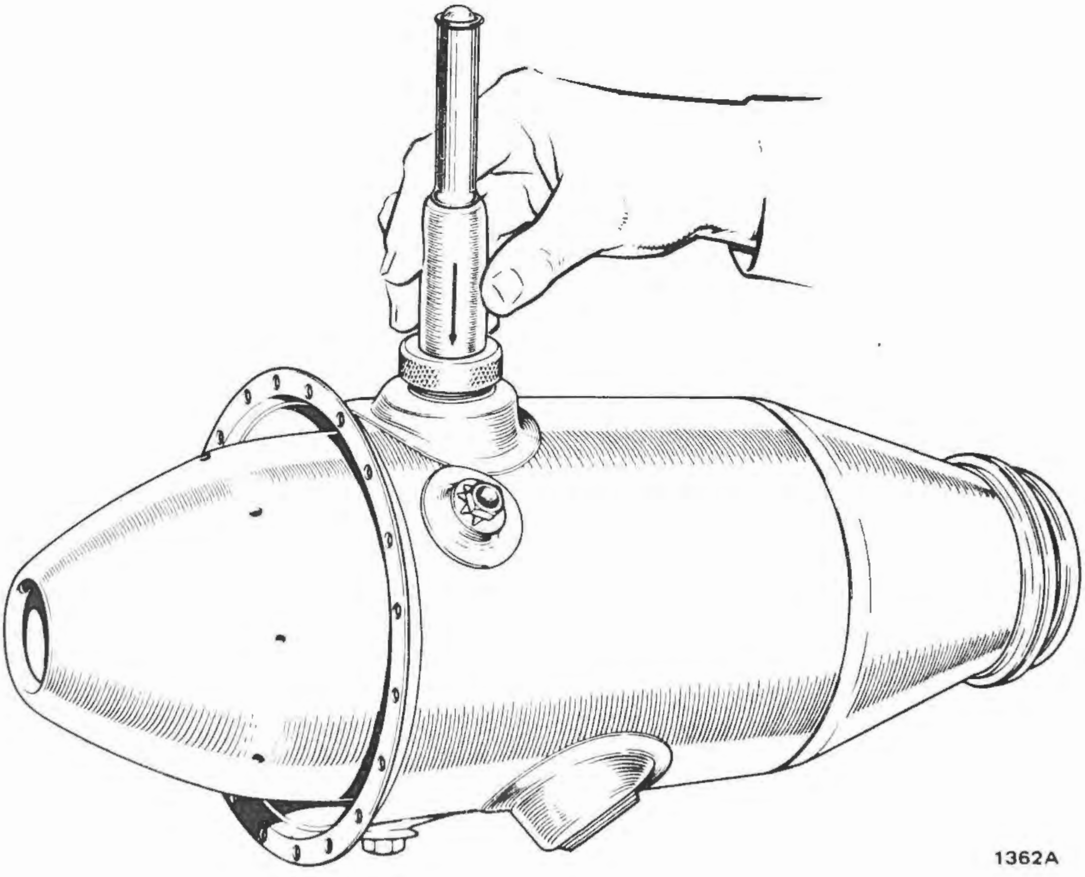
(a) Fit concentricity checking tool GU.18147 (pre-Mod.1147 and Mod.1147, S.B.Da72-205) to setting block HW.35052. Set the contact point to the nominal diameter of the interconnector by adjusting the contact until it lightly touches the bore of the setting block; this is indicated by the lamp illuminating.

NOTE: Concentricity checking tool HW.35033 may still be used to check pre-Mod.1147 air casings only.

(b) Insert the steel bush into the interconnector bore of the air casing (Fig.205), rotate the insulated inner member and check the indicator lamp. If the lamp does not illuminate, the concentricity of the bores is within acceptable limits.

(c) If the lamp illuminates, the concentricity of the bores is not within acceptable limits and the flame tubes and air casings must be interchanged until satisfactory alignment is obtained.

NOTE: The tool should be used gently and if the lamp illuminates, the direction of rotation should be reversed to prevent excessive wear to the contacts.



Checking the interconnector bores
Fig.205

(d) When both interconnector bores of all flame tubes are acceptable for concentricity, secure the locating pins by bending up the tabwashers.

(4) Apply a thin coating of jointing compound (Chap.89-1) to the mating faces of the expansion chamber and air casing.

(5) Fit the expansion chamber to the air casing/flame tube assembly, ensuring that the burner head enters the snout of the flame tube and the alignment marks of the casing flanges coincide.

(6) Fit the bolts, washers and nuts to the flange, ensure that the burner is located correctly in the flame tube swirl vane assembly, then tighten the securing nuts to the torque loading specified in Chap.89-3.

(7) Fit the anti-tear straps as instructed in para.2.B.(1) and/or (2).

(8) Renew, lubricate and fit the interconnector rubber sealing rings as instructed in para.1.B.(4).

(9) Fit the interconnectors as instructed in para. 1.B.(5).

(10) Fit the igniters to No.3 and 7 combustion chambers (Chap.80-2).

(11) Fit the combustion chambers to the engine as instructed in para. 1.B.(10)(a) to (n).

4. Adjustment/Test

If it is necessary to renew combustion chamber assemblies or flame tubes, changes in temperature traverse may occur at the turbine, even with identical modification standard combustion chamber assemblies. Dependent upon the number of the combustion chambers or flame tubes renewed, a significant change in the turbine gas temperature/fuel flow relationship may occur. It will be necessary to carry out a ground-run before and after combustion component renewal if the instructions in para.(2) (b) apply.

A. Ground-run procedure

(1) Provided that, during the life of the engine, the combustion chamber assemblies and/or flame tube changes together do not exceed a total of two, carry out the recommended serviceability ground-run as instructed in Chap.71-0, Sub-section 4.C.

(2) When, during the life of the engine, the combustion chamber assemblies and/or flame tube changes together exceed a total of two, carry out the following:

(a) If the rectification is to be effected with the engine 'in-situ' or if the engine is to be removed for rectification and re-installed in the same position, carry out an in-service ground-run as instructed in Chap.71-0, Sub-section 4.C. after the combustion chamber or flame tube changes.

(b) If the engine is to be removed for rectification and is not to be re-installed in the same position, carry out the following ground-runs as instructed in Chap.71-0, Sub-section 4.D.

Ground-run 1

(a) Is to be carried out before combustion chamber or flame tube changes in order to establish the torque pressure margin. The turbine gas temperature must be between Data-plate maximum and the maximum operating limit.

(b) If circumstances will not permit a ground-run immediately prior to a combustion component change, use the results obtained from the most recent ground-run for run 1.

(c) To ensure that the integrity of the controls setting is maintained during rectification, adjust the fuel control unit maximum stop to obtain a clearances of 0.0015 in. between the stop and the throttle valve lever (with the throttle fully open and the FUEL DATUM at full INCrease).

(d) Do not effect control rod adjustments, fuel control unit or propeller control unit changes between ground-runs 1 and 2.

Ground run 2

(a) Is to be carried out after combustion chamber or flame tube changes.

(b) After installation and prior to starting the engine, check that there is a clearances of 0.0015 in. between the fuel control unit maximum stop and the throttle valve lever (with the throttle fully open and the FUEL DATUM at full INCrease).

(i) If there is a clearance of 0.0015 in., adjust the maximum stop to obtain a nominal clearance of 0.070 in. from the throttle valve lever.

(ii) If the clearance of 0.0015 in. has been lost, re-set the controls (Chap.76) to restore the 0.0015 in. clearance, then adjust the maximum stop to obtain a nominal clearance of 0.070 in. from the throttle valve lever.

(c) During ground-run 2, check that the turbine gas temperature does not exceed the maximum operating limit.

(i) If the turbine gas temperature is between the maximum operating limit and maximum Data-plate turbine gas temperature (without the necessity of a controls adjustment) declare a new Mintorque value by subtracting the torque pressure excess value obtained during ground-run 1 from the corrected torque pressure value obtained during ground-run 2. This new Mintorque value must be between E.P.C.P. minus 15 p.s.i. and E.P.C.P. minus 60 p.s.i.

(ii) If a controls adjustment is necessary to bring the turbine gas temperature within the limits, amend the torque pressure excess value, i.e., if it is necessary to reduce the turbine gas temperature by 10 degrees C. then reduce the torque pressure excess value by 10 p.s.i. (1 p.s.i. of torque pressure is equal to 1 degree C. of turbine gas temperature).

(iii) If the turbine gas temperature is less than the Data-plate maximum, adjust the fuel flow to bring the turbine gas temperature within limits then declare the new Mintorque value as instructed in para.(c)(i).

(d) Obtain the new torque pressure upper limit by adding to the new Mintorque value, the difference between minimum Data-plate and maximum Data-plate turbine gas temperatures and adding 15 p.s.i. to this difference.

(e) Examine the units on which work has been done for evidence of gas blows, security and signs of leakage.

5. Inspection/Check

A. Combustion assembly

(1) Check the combustion assembly for general security and gas leaks from the joints, paying particular attention to the interconnectors.

(a) Examine the outer surface of each air casing for corrosion, paying particular attention to the areas adjacent to the seam and butt welds. If corrosion pitting of measurable depth is visible or if the protective coating on the surface of the casing has been removed, revealing widespread corrosion, fit a replacement air casing.

(b) On pre-Mod.1731 air casings, restore areas of the casing from which the protective coating is peeling or flaking, by light wire brushing, then applying one coat of air drying, high heat resisting enamel (Chap.89-1).

(c) On Mod.1731 (S.B.Da72-422) air casings, restore damaged areas of the protective coating as follows:

(i) Using water-proof abrasive paper (Chap.89-1), rub the damaged area until it is blended smoothly into the surrounding area.

(ii) Using a clean cloth soaked in trichloroethylene (Chap.89-1), degrease the area to be restored; allow to air dry until solvent has evaporated, or use a clean, dry, oil-free air blast.

(iii) Wipe the prepared surface with a clean, lint-free, cloth wetted with Sermetel 'W' (Chap.89-1).

(iv) Mix thoroughly the corrosion resistant touch-up coating (Chap.89-1) and brush apply one coat; allow to air dry for 30 minutes.

(d) Examine the air casings for local overheating and for cracks, particularly in the vicinity of welded joints. Closely examine the circumferential weld at the rear of the front flange and the longitudinal weld in the parallel section on the same axis as the burner cleaning boss on Mod.855 air casings, or on the longitudinal axis midway between the two outward-facing flame tube suspension pin bosses on pre-Mod.855 air casings. If Mod.1183 (pre-Mod.1410) combustion chambers are fitted, evidence of localized overheating will be indicated by a 'hot spot' or bulge on the air casing approximately 5.500 in. downstream of, and in line with the upstream interconnector. A combustion chamber with a confirmed hot spot or bulge must be changed.

B. Combustion chambers

(1) Return the complete combustion chamber assembly (including the burner) for overhaul if a combustion chamber has to be changed, as in the case of a hot spot on the air casing.

(2) Thoroughly investigate any gas leaks; these are usually indicated by sooty deposits around the point of leakage. Abnormal soot deposits, visible at the trailing edge of the anti-tear straps, could originate from cracks in the air casing.

(3) Remove the anti-tear strap (if fitted) if failures of an air casing is suspected and visually examine the air casing for cracks, paying particular attention to the areas around the suspension pin interconnector soleplates. Any areas of the casing suspected of containing cracks must have the protective coating removed to enable the metal of the casing to be examined. If the cracks are confined to the protective coating only, the air casing may be considered satisfactory, providing it is reprotected as instructed in para. 5.A.(1)(b) or (c). If the metal of the casing is cracked and this is associated with rough running, the engine must be rejected.

(4) If an air casing is cracked, but the cracks are not associated with rough running, examine the turbine, refer to 72-6, the compressor, refer to 72-3, the compressor outlet elbows and the oil filters, refer to 72-8 for damage. If these components are free from damage, the engine is acceptable for further service, provided a replacement air casing is fitted.

(5) Inspect the air casing rear sealing land for wear. If wear exceeds 0.010 in. in depth over an arc of 3.000 in. or more, reject the air casing: replace with a serviceable air casing ensuring the correct Mod. standard.

C. Anti-tear straps

(1) Inspect the anti-tear strap for damage and cracks, paying particular attention to the area round the welded joints. Examine the packing piece for damage, cracks and deterioration.

D. Flame tubes

(1) Full inspection of flame tubes at part life periods is not required unless specifically associated with a particular life development programme. Under these circumstances the overhaul agency concerned will advise the necessary inspection standards.

(2) However, any time a combustion chamber is removed from an engine, check the tightness of the 3 rivetted flame tube front cooling ring segments.

NOTE: This may be done by pulling the front cooling ring segments fore and aft by hand.

(3) If any movement of a segment is detected, or if a segment has become detached from one or more rivets, do not refit the flame tube: fit a serviceable replacement flame tube ensuring the correct mod. standard.

(4) If complete detachment of a cooling ring segment has occurred refer to 72-6, 2.C. (1) and (2).

(5) If appreciable areas of flame tube material have been released refer to 72-6, 2.C.(1) and (2).

(6) If the rest of the flame tube is cursorily inspected the following acceptance standards are given only as a guide:

(a) Cracks which are confined to the ring of small cooling air dilution holes are acceptable, provided that the maximum length of the cracks do not exceed 7 static holes. If the cracks propagate towards the adjacent rivets or circumferentially around the base of the interconnectors, this is unacceptable: replace the unacceptable flame tube with a serviceable flame tube ensuring the correct mod. standard.

(b) Any other visual damage, such as cooling ring distortion and cracking, break up, distortion and cracking around the secondary air holes, cracking of the burner cleaning holes, and burning and break up of the interconnectors (but not circumferential cracks around the base) is considered acceptable for completion of engine life.

E. Interconnectors

(1) At the recommended routine inspection periods and before soft blasting the compressor, refer to 72-3, examine the combustion chamber interconnectors, and surround area for evidence of gas leaks.

(a) Renew the interconnector sealing rings (pre-Mod.1473) if the interconnector can be rotated by light finger pressure as this condition denotes serious deterioration of the sealing rings.

(b) If Mod.1473 interconnectors are fitted and the interconnector can be rotated, then provided that there is no evidence of gas leakage the interconnector may be considered serviceable.

(c) Do not apply excessive pressure to the interconnectors when effecting the rotational check as subsequent gas leakage can occur if the seals are disturbed or damaged.

(d) Renew the interconnector sealing rings if obvious soot deposits are present.

NOTE: The maximum satisfactory engine life which can be achieved without severe gas leakage due to deterioration of the interconnector rubber sealing rings (pre-Mod.1473) varies, depending upon the type of operation to which the engine has been subjected, and individual experiences within a given operation may make it preferable to change the sealing rings at part engine life on a routine basis.

F. Suspension

NOTE: Prior to inspection of the flame tube suspension features, refer to 4. 'Adjustment/test' and to Chapter 89-4.

(1) Inspect the integrity of the flame tube suspension in accordance with Alert Service Bulletin Da72-A413 or Service Bulletin Da72-420 as appropriate to the modification standard of the engine.

DESCRIPTION

TURBINE AND NOZZLE BOX

The stream of high-velocity gas discharged from the combustion chambers is directed through seven discharge nozzles into the turbine where most of its energy is converted into torque. This torque, transmitted through the engine main shaft assembly, drives the compressor, propeller, and accessory units.

The turbine incorporates three stages; these are known as the high pressure, intermediate pressure and low pressure stages. The whole assembly is contained within the nozzle box (fig. 1) which is secured, by the nozzle box mounting drum, to the intermediate casing.

Each turbine stage consists of a turbine wheel and an assembly of nozzle guide vanes, the guide vanes being positioned adjacent to, and immediately upstream of, the turbine wheel blades. The guide vanes are angled to direct the gasflow on to the blades of the adjacent turbine disc at the most efficient angle of attack. In section, the guide vanes are of aerofoil shape and therefore slightly increase the velocity of the gases passing over them. The twelve thermocouples, which measure the turbine gas temperature (T.G.T.), are located in the intermediate nozzle guide vanes.

The turbine blades are also of aerofoil shape in section and are arranged around the discs in an angular position. The gas flow, having impinged upon a blade, is deflected by the shape and angle of the blade into a change of direction, thus producing additional thrust on the blade by reaction.

ROTATING ASSEMBLY

The turbine rotating assembly, consisting of the three turbine discs, is secured to the engine main shaft assembly, i.e. the concentrically arranged compressor and propeller reduction gear drive shafts, by ten bolts each of which have tapered sections on the shank to locate the turbine discs radially. Five of these bolts pass through the H.P. and I.P. discs, and secure them to the flanged ends of the shaft assembly. Similarly, the remaining five bolts pass from the shaft assembly through all three discs and secure the L.P. disc.

The whole assembly of discs and shafts is supported immediately forward of the H.P. disc by a ball thrust bearing and a plain bearing (fig. 2). The turbine blade assemblies are secured to their respective turbine disc by a 'fir-tree' shaped root on each blade. These roots are fitted into a series of corresponding slots broached in the periphery of the turbine discs. Each blade is located axially between a tongue which projects from the root to lap over the turbine disc front face, and a locking plate which engages with a slot in the rearward end of the blade root.

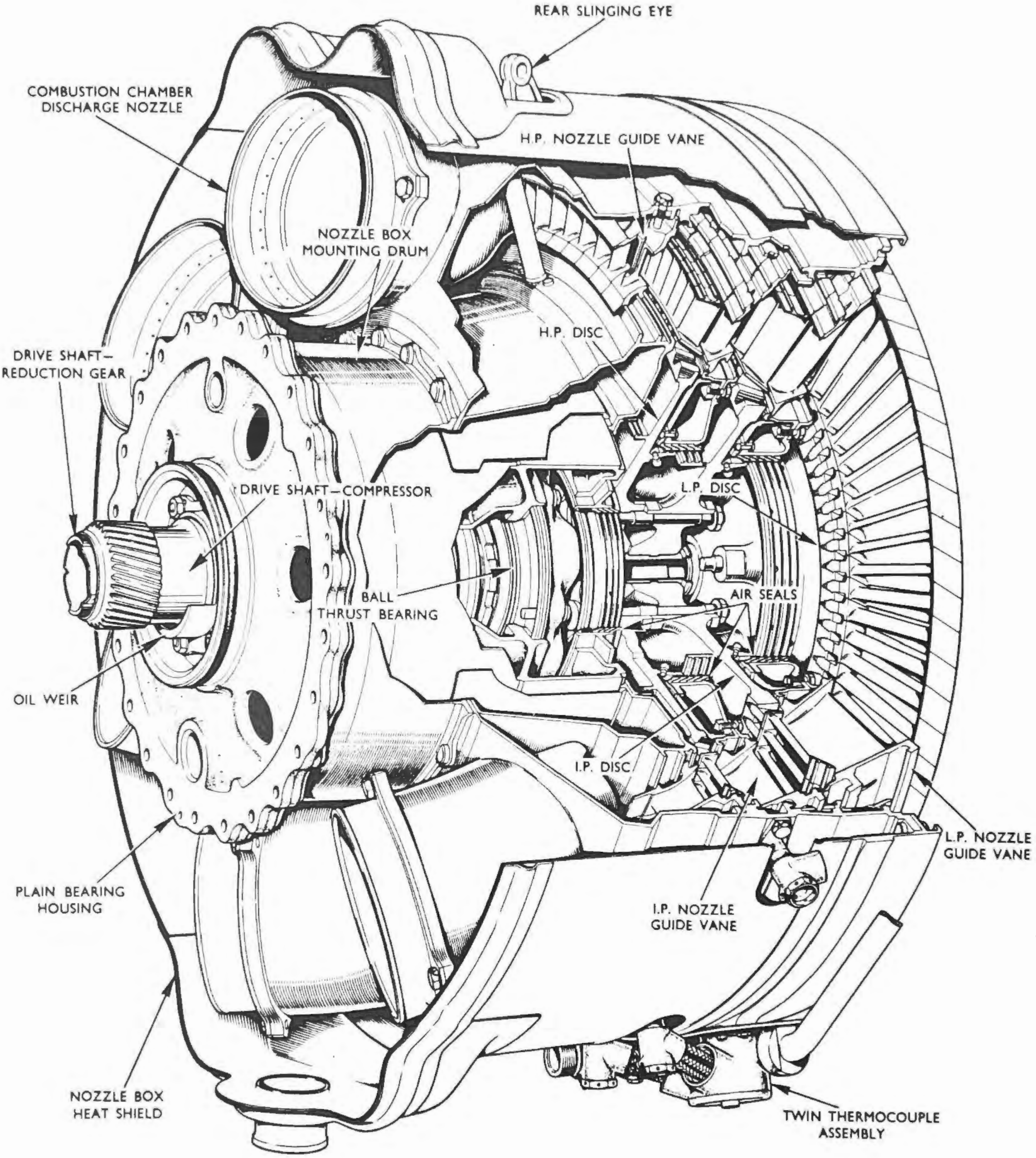


Fig. 1 Nozzle box and turbine

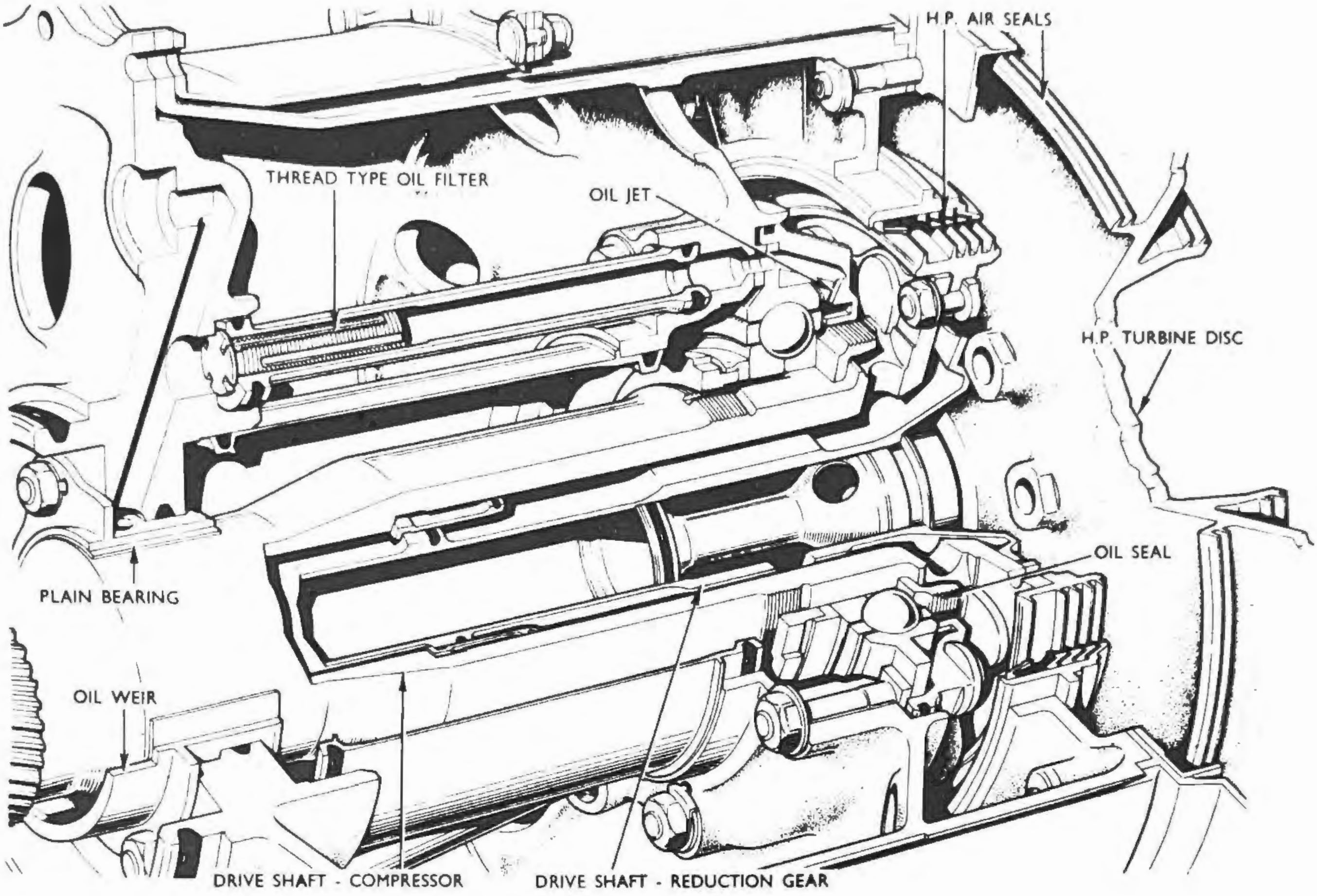


Fig. 2 Turbine bearing

Each locking plate secures a group of either 2 or 3 blades (fig. 3), depending upon circumferential location, and is expendable.

Each blade has an integral shroud segment at its outer end; when the blades are assembled these segments combine to provide a complete rotating shroud around each turbine wheel to control the gas flow at the blade tips.

A continuous sealing lip is formed on the front face of each shroud and the shrouds formed by the H.P. and I.P. blade assemblies have two additional sealing lips on their peripheral surfaces. The sealing lips correspond with faces formed by the combined nozzle guide vane platforms and prevent gas losses over the blades.

A circular steel guard is fitted at the rear end of the nozzle box to contain any debris from the L.P. stage turbine in the event of a failure.

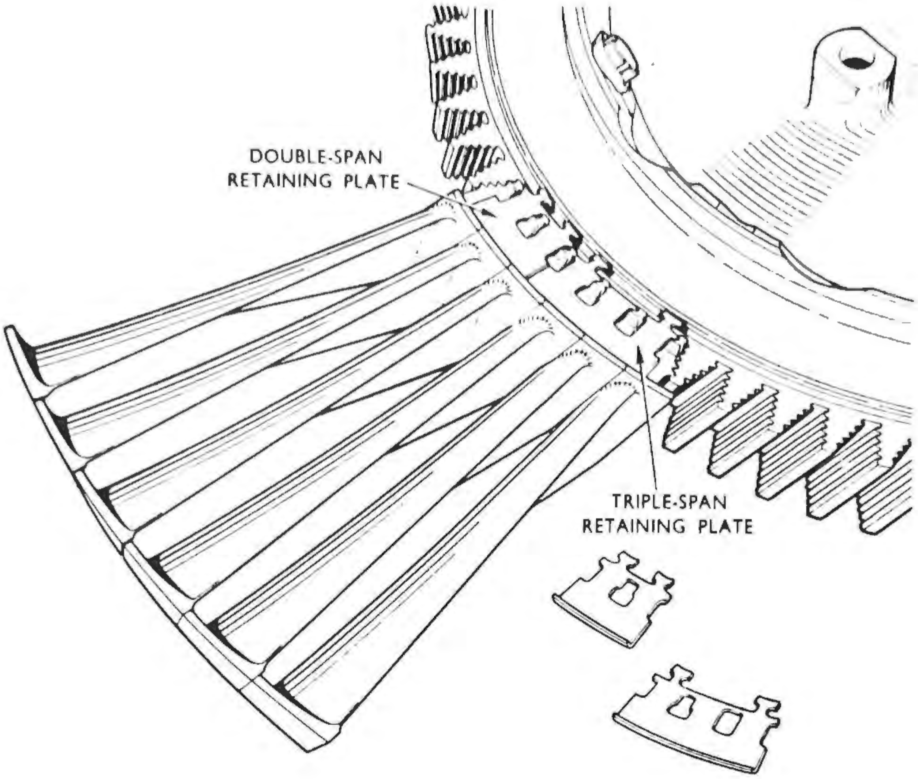


Fig. 3 Turbine blade attachment locking plate

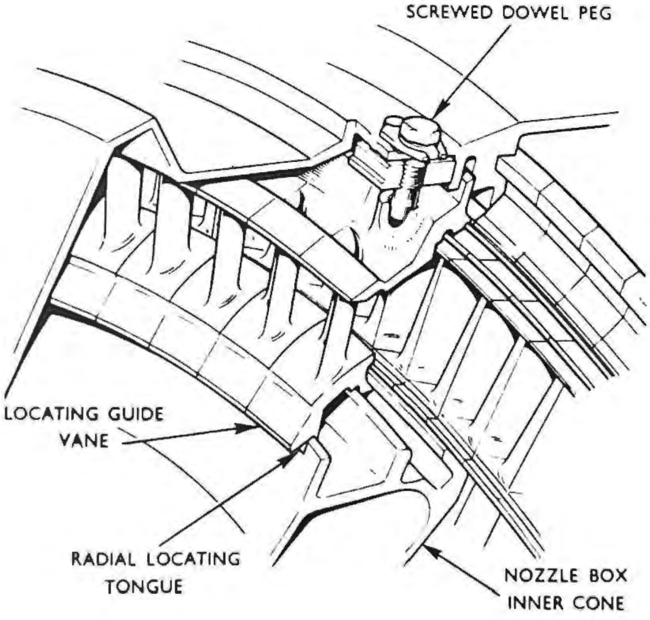


Fig. 4 H.P. nozzle guide vane location

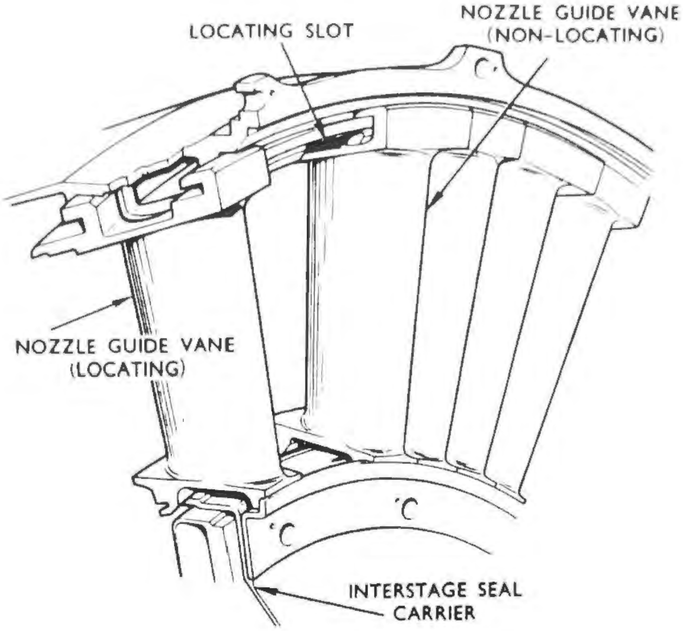

LOCATING SLOT
NOZZLE GUIDE VANE (NON-LOCATING)
NOZZLE GUIDE VANE (LOCATING)
INTERSTAGE SEAL CARRIER
2688

Fig. 5 L.P. nozzle guide vane location

NOZZLE GUIDE VANES

The high pressure nozzle guide vanes are mounted between the outer casing and slotted flanges on an inner cone. The inner cone is attached to the nozzle box mounting drum and the rear bearing housing, and is positioned concentric with the nozzle box outer casing by adjusting washers on radial tie bolts. The high pressure guide vanes are located axially by tongues which engage with the flanges of the inner cone and radially by every fifth guide vane. Each of these locating guide vanes has a tongue engaging in a slot in the inner forward cone flange, while a drilled boss on the guide vane outer platform accommodates a dowel peg which is screwed through the nozzle box outer casing, as illustrated in fig. 4.

The intermediate and low pressure nozzle guide vanes are located axially and radially by tongues which protrude from the outer platforms and engage in slotted flanges on the inner wall of the nozzle box (fig. 5). Each alternate guide vane engages in one of the axial slots and locates the guide vane assembly radially. The inner ends of the guide vanes carry an interstage diaphragm and seal carrier assembly upon which the interstage labyrinth seals are mounted.

For turbine cooling and sealing, high and low pressure air is supplied from the first and second-stage compressors; this is described in 72-9

TURBINE AND NOZZLE BOX - MAINTENANCE PRACTICES

1. Removal/Installation

A. Discharge nozzles

(1) Remove the discharge nozzles

(a) Remove the combustion chambers as instructed in Chap. 72-5.

(b) Remove the 3 setscrews and tabwashers securing each discharge nozzle.

(c) Extract the discharge nozzles from the nozzle box using extraction tool GU.11678. If this tool is not available, ease the nozzles out of their locations.

CAUTION: DO NOT DAMAGE THE FLANGES OF THE DISCHARGE NOZZLES AND THE NOZZLE BOX.

(2) Install the discharge nozzles.

(a) Using solvent, specified in Chap. 89-1, remove any trace of old jointing compound from the faces of the nozzle box flanges.

CAUTION: ENSURE THAT THE NOZZLE BOX IS FREE FROM ALL FOREIGN OBJECTS.

(b) Apply jointing compound, specified in Chap. 89-1, to the nozzle box discharge nozzle sealing face only; use the jointing compound sparingly to avoid blocking the cooling air holes but ensure a full and even application.

(c) Locate the nozzles in the nozzle box, checking that each nozzle does not foul the tie bolt securing the inner cone assembly.

CAUTION: ENSURE THAT THE OUTLET DUCT OF EACH DISCHARGE NOZZLE LOCATES BETWEEN THE INNER AND OUTER PLATFORM LEADING-EDGE LIPS OF THE H.P. NOZZLE GUIDE VANES; REFER TO FIG.1.

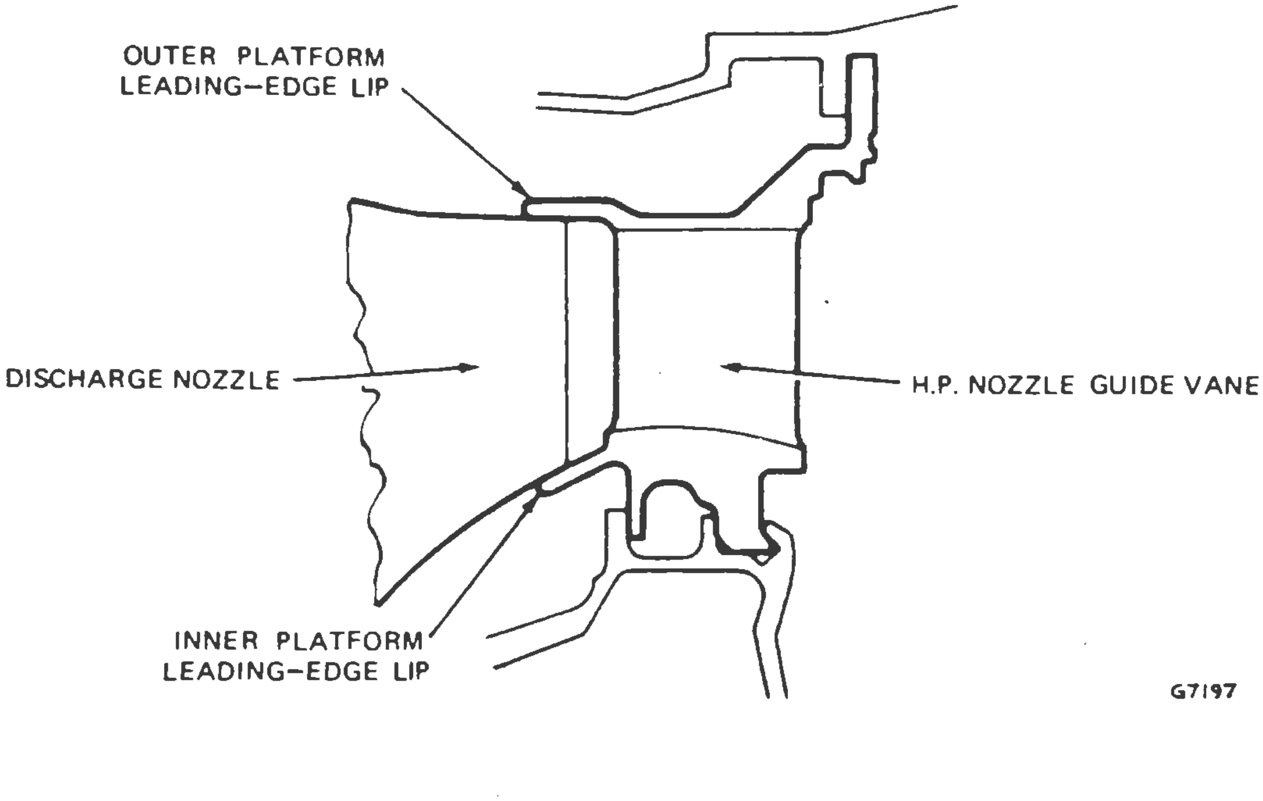
(d) Using a hide-faced mallet lightly tap the discharge nozzles until seated, taking care not to distort the flanges.

(e) If, due to interference fit, difficulty in seating the discharge nozzles is experienced, carefully free the nozzles from their locations; shrink the discharge nozzles by immersing them in an approved freezing medium, preferably liquid nitrogen, then refit the discharge nozzles.

(f) Fit one end of the bonding lead under the head of the setscrew adjacent to the drain connection on the nozzle box, apply anti-seize compound, specified in Chap. 89-1, to the setscrew threads then secure each discharge nozzle with 3 setscrews and tabwashers.

(g) Torque tighten the setscrews to 75 lb. in., then bend up the tabwashers.

(h) Install the combustion chambers as instructed in Chap. 72-5.



Correct engagement of discharge
nozzles and H.P. nozzle guide vanes
Fig.1

B. H.P. nozzle guide vanes (Mod.1674), Fig.2.

(1) Remove the H.P. nozzle guide vanes

(a) Prior to replacement of H.P. nozzle guide vanes in service (refer to para.2.B. (2)(d)), clean the compressor as instructed in Chap.72-3 using the lignocellulose grit specified in Chap.89-1.

(b) Ground-run the engine to establish a datum turbine gas temperature and the torque pressure margin as instructed in Chap.71-0, Sub-section 4.D., 'REMOVAL/RE-INSTALLATION GROUND RUNS - DRY'.

(c) Remove the power plant and mount it on a suitable power plant stand.

(d) Remove the combustion chambers as instructed in Chap.72-5.

(e) Remove the discharge nozzles as instructed in para.1.A. (1).

(f) Remove the exhaust unit as instructed in Chap.72-7.

(g) Remove the thermocouple harness as instructed in Chap.77-2-1.

(h) Remove the circlip, sealing plate, spring and bonding clip from the cooling air outlet tube.

(j) Remove the circlip which secures the cooling air outlet tube to the heat-shield and withdraw the tube assembly from the bore in the nozzle box; remove and discard the gland rings.

(k) Remove the 12 nuts which secure the heat-shield to the nozzle box and remove the heat-shield.

(m) Sever and remove the locking wire from the break neck screw and locking plate of the locating H.P. nozzle guide vane nearest to and/or most accessible to the H.P. nozzle guide vane(s) to be replaced; refer to Fig.2.

(n) Unlock the locating pin tabwasher and remove the locating pin and locking plate.

NOTE: Penetrating oil, specified in Chap.89-1, can be used to assist in the removal of the locating pin and break neck screw.

(p) To prevent loss of the tapped locating plate, inside the nozzle box, thread a length of wire through the locating pin hole in the nozzle box and locating plate.

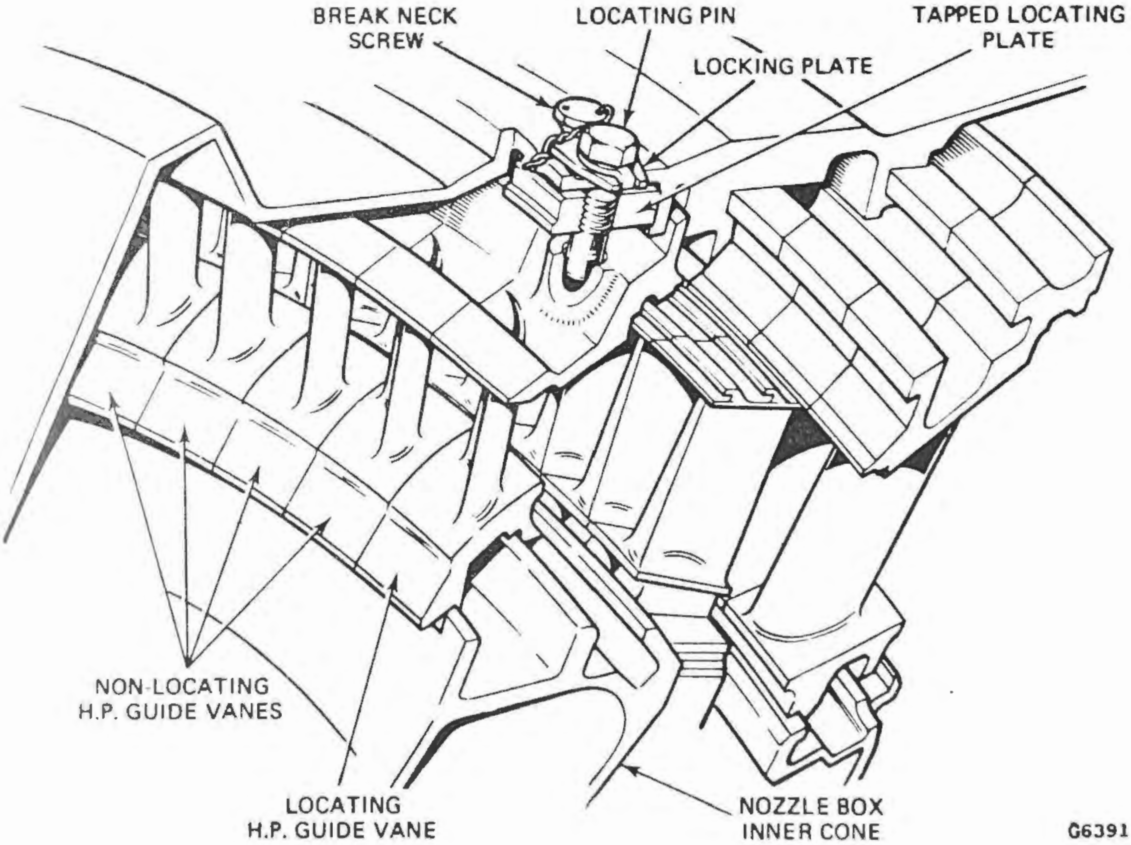
(q) Remove the break neck screw and the tapped locating plate.

(r) Remove the locating H.P. nozzle guide vane from its location by sliding it out in a forward direction.

(s) As required, remove the four adjacent non-locating nozzle guide vanes on each side of the locator position by sliding them circumferentially around to the locator position then out in a forward direction.

NOTE: Difficulty may be experienced in moving some non-locating nozzle guide vanes due to slight distortion and frettage wear which occurs in the H.P. nozzle guide vane slots during normal service running. Extractor tool GU.21299, which fits over the aerofoil of the nozzle guide vane, can be used to assist in moving these guide vanes.

(t) Repeat operations in para. (m) to (s), as required, to replace unserviceable H.P. nozzle guide vanes at the remaining locations in the nozzle box.



H.P. nozzle guide vane location
Fig.2

Turbine and nozzle box - Maintenance practices (cont.)

(2) Install the H.P. nozzle guide vanes.

NOTE: It is considered advisable that new nozzle guide vanes be fitted in the locations where deterioration has occurred, and that existing serviceable nozzle guide vanes be re-fitted in their previous locations.

(a) Fit each non-locating H.P. nozzle guide vane at the locator position and push it in, in a rearward direction, then slide it around circumferentially to its' location.

NOTE: Extractor tool GU.21299 can be used, if required, to assist in moving the nozzle guide vanes circumferentially to their correct locations.

(b) Fit the locating H.P. nozzle guide vane into its' location and place the tapped locating plate into position on the inside of the nozzle box.

(c) Smear the break neck screw threads with anti-seize compound, specified in Chap.89-1, then fit and torque tighten it to 30 lb.in. maximum.

(d) Smear the H.P. nozzle guide vane locating pin threads with anti-seize compound and fit the locking plate, tabwasher and locating pin, then torque tighten the pin to 60 to 70 lb.in.

(e) Rotate the turbine, by hand, and check the engine for freedom of rotation.

(f) If the freedom of rotation check is unsatisfactory, refer to Chap.71-0, 'POWER PLANT - TROUBLE SHOOTING'.

(g) If the freedom of rotation check is satisfactory bend up and lock the locating pin tabwashers and wire-lock the break neck screw to the locking plate (Fig.2) with 22 S.W.G. stainless steel wire specified in Chap.89-1.

(h) Smear the threads of the heat-shield retaining studs with anti-seize compound specified in Chap.89-1.

(j) Fit the heat-shield and secure it with the 12 nuts; torque tighten the nuts to the loading specified in Chap.89-3.

(k) Fit a gland ring, gland washer and spring to the inner side of the cooling air outlet tube flange (i.e., on the longer end) and insert the tube through the orifice in the heat-shield and into the bore in the nozzle box.

Turbine and nozzle box - Maintenance practices (cont.)

(m) Fit a gland ring and washer to the outer side of the cooling air outlet tube flange and into the housing in the heat-shield; secure the assembly to the heat-shield with the circlip.

(n) Fit the sealing plate spring and sealing plate (lip uppermost) to the outer end of the cooling air outlet tube and secure them with the circlip.

(p) Fit the bonding lead clip to the cooling air outlet tube.

(q) Install the thermocouple harness as instructed in Chap.77-2-1.

(r) Install the exhaust unit as instructed in Chap.72-7.

(s) Install the discharge nozzles as instructed in para.1.A. (2).

(t) Install the combustion chambers as instructed in Chap.72-5.

(u) Install the power plant.

(v) Start the engine as instructed in Chap.71-0, Section 3, 'ENGINE STARTING, MOTORING AND STOPPING DRILLS', then run-in as follows:

R.P.M.	Duration (minutes)
Ground idling	3
10,000	2
11,500	2
14,200	2
15,000	4

(w) Finally, effect a re-installation ground run as instructed in Chap.71-0, Sub-section 4.D., 'REMOVAL/RE-INSTALLATION GROUND RUNS - DRY'.

Turbine and nozzle box - Maintenance practices (cont.)

2. Inspection/Check

The condition of the turbine assembly is critical to engine performance and reliability and is therefore of major importance in assessing the serviceability of the engine. Effect the following inspection checks at the recommended periods.

NOTE: Failure of a turbine blade may result in cracking of certain external features on the engine due to secondary vibration, not necessarily apparent as rough running; refer to 'Rough running' under 'Engine, Trouble shooting'.

A. Inspect the L.P. turbine blades and L.P. nozzle guide vanes, using a bright spotlight, turning the engine by hand as required.

(1) Accept the engine provided that the damage does not exceed the following conditions:

(a) Slight impact damage to turbine blades, or bent or damaged blade shrouds, provided that the metal is not cracked or torn.

(b) Slight impact damage to nozzle guide vanes or an isolated case of slight cracking or buckling of a nozzle guide vane.

(2) Reject the engine if any of the following conditions are found:

(a) Turbine blades which are cracked or torn, or which have a segment missing.

(b) Any measurable depth of scoring on the turbine L.P. disc, caused by rubbing on the exhaust unit inner cone.

(c) DELETED

(3) Inspect the L.P. turbine blades and L.P. nozzle guide vanes for evidence of metallic deposits, e.g. aluminium.

NOTE: Aluminium deposits on the L.P. turbine blades or L.P. nozzle guide vanes may be an indication of compressor damage, or may be caused by flaking of the internal protective coating of the combustion chambers air casings.

(a) If there is evidence of metallic deposits on the L.P. turbine blades or nozzle guide vanes, remove the combustion chambers, as instructed in Chap.72-5, and examine the following areas for definite indications of metallic deposits or impact damage.

(i) The compressor outlet elbow cascade vanes.

(ii) The frontal area and the interior of the flame tubes.

(b) Reject the engine if there are definite indications of metallic deposits or extensive impact damage within the areas stated in para.(a) (i) and (ii).

(c) If there is no evidence of metallic deposits or extensive impact damage on the cascade vanes or flame tubes, dismantle the combustion chambers, as instructed in Chap.72-5, and examine the internal surface of each air casing for evidence of flaking of the protective coating.

(d) If flaking of the internal protective coating is evident, the engine can be considered to be serviceable provided that the affected air casings are reprotected, as instructed in the appropriate overhaul manual, or that serviceable replacement air casings are fitted.

NOTE: If it is necessary to change any complete combustion chamber assemblies, refer to Chap.72-5, 4. 'Adjustment/Test', for instructions on engine ground running procedures subsequent to combustion chamber renewal.

(4) If any of the following conditions are evident on inspection of the L.P. turbine, inspect the H.P. nozzle guide vanes and H.P. turbine blades.

(a) Damage other than slight to the L.P. nozzle guide vanes and turbine blades.

(b) Cracking and buckling of several L.P. nozzle guide vanes.

(c) Signs of overheating (surface texture of blades and vanes), supported by history of engine.

NOTE: Damage caused by excessive turbine gas temperature will not necessarily be apparent when carrying out a visual inspection.

(d) If the extent and duration of the overheating are known to have exceeded the limits detailed in 'Engine, Adjustment/Test', reject the engine.

(e) Unusual noise associated with the turbine when the engine is rotated, and/or engine is stiff to turn.

B. If called for in para.A. (4), remove one or more combustion chambers (Chap.72-5) and inspect the H.P. turbine blades and nozzle guide vanes.

(1) Accept the engine provided that the damage does not exceed the following conditions:

(a) Slight impact damage to H.P. turbine blades, or bent or damaged blade shrouds, provided that the metal is not cracked or torn.

(b) Damage to H.P. nozzle guide vanes within the following limits.

(i) Slight impact damage.

(ii) Burning, erosion, cracking or holing, provided that at least one third of the chordal dimension of the worst vane remains intact.

(iii) Where several vanes are severely burnt, re-examine them at the next inspection period (maximum 150 hours).

(c) If overheating is suspected but not reported, check the pyrometry system as instructed in Chap.77-2-1.

(2) Reject the engine if any of the following conditions are found:

(a) H.P. turbine blades with extensive impact damage, or which are cracked, torn or eroded, or which have a segment missing.

(b) H.P. turbine blades showing blistering of the aluminized surface; this applies only to engines embodying Mod.1148 (S.B.No. Da.72-188) or Mod.1258 (S.B.No. Da.72-201).

NOTE: Such blistering is indicative of an overheat and is generally found on the concave aerofoil surface immediately below the outer shroud platform.

(c) H.P. nozzle guide vanes with extensive impact damage or which are burnt or cracked completely through or beyond the limits stated in para. B. (1) (b).

(d) On engines embodying Mod.1674 (S.B. Da72-399) where considerable further running is planned i.e., in excess of 1,000 hours, replace any H.P. nozzle guide vanes featuring open cracks which exceed 0.250 in. in length on the leading or trailing edges; refer to para. 1.B. (1) and (2) for replacement instructions.

Turbine and nozzle box - Maintenance practices (cont.)

(3) If there are any indications of metallic deposits, e.g. aluminium, on the H.P. nozzle guide vanes or H.P. turbine blades, refer to para. A. (3) (b) to (d), for further instructions.

(4) If no cause can be found for unusual noise and/or stiffness in turning the engine, suspect seal rub; refer to Chap.71-0, 'POWER PLANT - TROUBLE SHOOTING', Rough running.

(5) Inspect the discharge nozzles

(a) Inspect the air casing locating bore. If wear exceeds 0.010 in. in depth over an arc of 3.000 in. or more, reject the discharge nozzle; replace with a serviceable discharge nozzle ensuring the correct Mod. standard.

(b) Inspect the flame tube locating bore. If wear exceeds 0.015 in. in depth over 50 per cent or more of the circumference, reject the discharge nozzle; replace with a serviceable discharge nozzle ensuring the correct Mod. standard.

C. Check the passages between adjacent H.P. nozzle guide vanes for blockage; refer to Chap.72-5, para. 5.D. (4) and (5).

(1) If a cooling ring segment or flame tube material has lodged in the H.P. nozzle guide vanes assembly, face on to the gas stream, such that 5 or more passages between adjacent H.P. nozzle guide vanes are blocked, reject the engine and fit serviceable replacement turbine discs.

(2) If the blockage is less than that stated, remove the obstruction(s) and return the engine to service.

DESCRIPTION

EXHAUST UNIT

The exhaust unit is bolted to the nozzle box and is interchangeable between port and starboard engines, the different angular positions being catered for by alternative holes in the mounting flange.

The unit controls the flow of exhaust gases from the turbine and maintains the lowest possible turbine outlet pressure, thus allowing maximum turbine efficiency.

The unit consists of two concentric cones, both of which are fabricated from heat-resisting sheet steel. The annular passage formed between the inner and outer cones carries the exhaust gas stream; back pressure on the turbine from the exhaust gases is reduced to a minimum by the increasing cross-sectional area between the cones.

Three support fairings hold the inner cone in position and also direct the gases emerging from the L.P. turbine into a straight rearward flow, thus minimizing frictional losses. Each fairing is secured by setscrews to a sole plate on the outer cone.

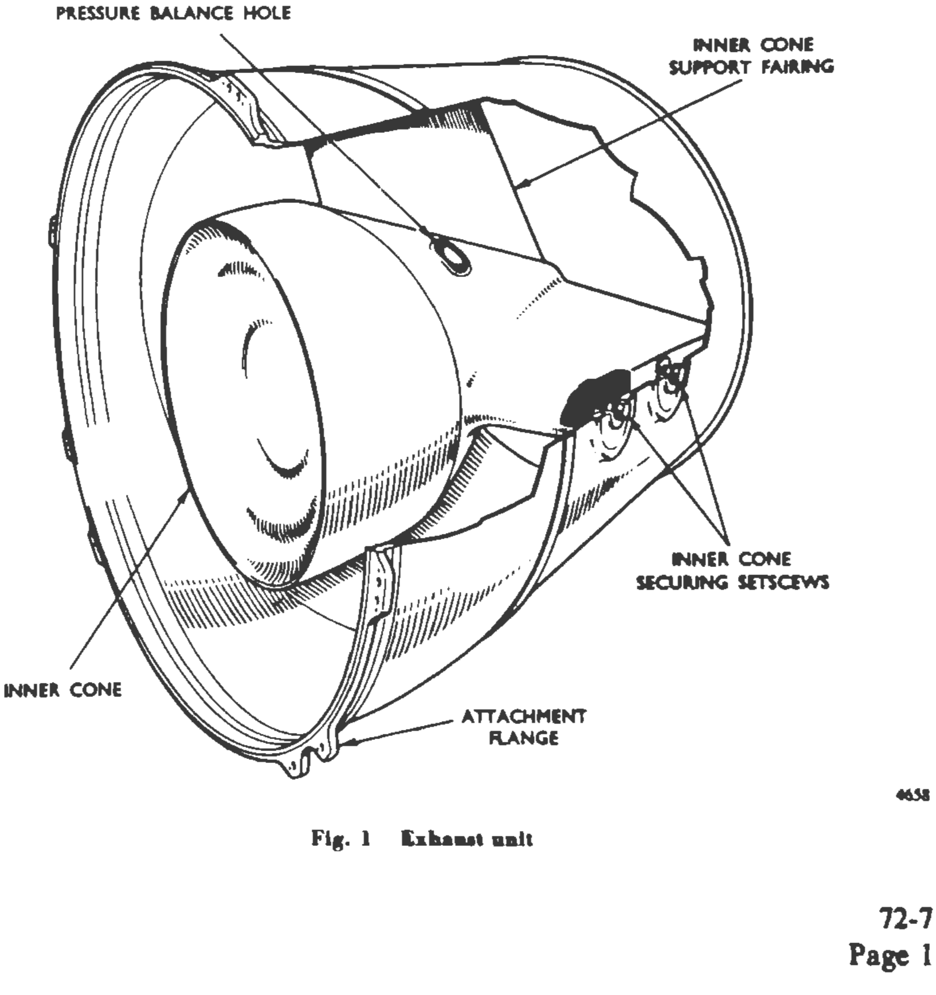


Fig. 1 Exhaust unit

The interior of the inner cone is vented to the exhaust gas stream by three circumferentially positioned holes to prevent a pressure difference occurring which may damage the cone. Drain holes are also incorporated to eliminate any residual fuel.

When the engine is installed the exhaust unit is arranged within a conical shroud with its discharge end centrally positioned in the jet pipe inlet. An annular gap, formed between the discharge end of the unit and the jet pipe inlet, permits an ejector effect from the exhaust gas stream; this induces an airflow from the combustion compartment, along the annular passage formed between the exhaust unit outer cone and its surrounding shroud, into the main gas stream in the jet pipe. A flow of cooling air is thus provided over the whole combustion compartment.

MAINTENANCE PRACTICES

EXHAUST UNIT

SERVICING

At the recommended period, check the exhaust unit and inner cone for security, and the annular gap at the rear end, between the exhaust unit rear rim and the inner wall of the jet pipe cone, to ensure that it is at least 1/4 in. at its narrowest point.

Inspect the exhaust unit, with the aid of a bright spotlight, for damage and cracking, paying particular attention to the apex of the trailing edge end-cap on the inner cone. Cracking or damage of the exhaust unit is unacceptable, except as described under, 'Assessment for extended life, Inspection'.

If metallic deposits, e.g. aluminium, are evident in the exhaust unit, refer to Chap.72-6, 'Inspection/Check' para.A.(3)(b) to (d), for further instructions.

REMOVAL

To permit the removal of the exhaust unit, remove the engine from the aircraft.

Remove the eight tabwashered setscrews which secure the blade failure guard to the heatshield and withdraw the guard.

Remove the seven tabwashered nuts which secure the exhaust unit to the nozzle box and heatshield and after noting the position of the two distance pieces, withdraw the unit. Temporarily replace the nuts to retain the bolts in the nozzle box.

If the removed exhaust unit is to be packed for transport, refer to 'Storage'.

REPLACEMENT

If a replacement unit is being fitted, ensure that it is installed in the correct angular position. Fit the unit with the droop angle of the outer cone centrally positioned and then turn the unit through 72 degrees to port or starboard depending upon the respective installation.

Note that only five of the securing bolts engage with holes in the exhaust unit flange. A distance piece is placed over each of the other two bolts to form a seal with the rim of the exhaust unit. These distance pieces must be placed on the correct bolts as follows:

Viewing from the rear and proceeding clockwise with No.1 bolt at the top of the engine, fit distance pieces to bolts 3 and 7 for a port installation, or to bolts 2 and 7 for a starboard installation.

Note: The suffix 'D' to the engine mark number denotes a non-standard type of nozzle box is fitted. On these engines, special 'handed' port and starboard exhaust units are required, each being attached by four securing bolts only.

STORAGE

When a unit is to be transported or stored, use the exhaust unit packing case. The case is fitted with a locating ring at the bottom and securing bars at the top.

Normally no inhibiting treatment is necessary, but if a unit is to be shipped overseas it should be cocooned before packing.

ASSESSMENT FOR EXTENDED LIFE

When an exhaust unit has reached its normal overhaul life, i.e. the overhaul life of the engine, it can be released for a further life period, without return for overhaul, provided the inspection procedure detailed below establishes that the unit is not cracked or distorted beyond acceptable limits.

A record should be kept so that when the unit is ultimately returned for overhaul, it can be labelled with the total hours since new or overhaul.

When an exhaust unit is to be transferred to another engine it will be convenient to carry out the inspection procedure and thereby clear the unit for a further life.

Cracking on the unit is only acceptable when confined to minor cracks in the outer cone, as described later.

Strip

With the exhaust unit removed from the engine, unscrew the three pairs of $5/_{16}$in. tabwashered setscrews which secure the inner cone to the outer cone, then lift out the inner cone.

To assist inspection, both the inner and outer cones should be completely or locally crack tested using chalk and oil, Ardrox or similar penetrant.

Inspection

Outer cone

Carry out a detailed examination of the cone for signs of cracking, paying particular attention to the rolled rear edge.

Maintenance practices (cont.)

Minor circumferential cracks in the rolled rear edge of the outer cone can be accepted up to 0.150in. in length. Longitudinal cracking at this section is not acceptable. Any cracking elsewhere on this component is not acceptable.

Inner cone

Cracking of any kind is not acceptable.

Experience has shown that cracking is more likely to occur on this component than elsewhere, and in particular at the following regions:

(1) TRAILING EDGE SECTION - This should be inspected for cracks in the vicinity of the centre piece; use a X5 magnifying glass.

(2) WELDED JUNCTIONS - Inspect for skin cracking, paying particular attention to the three positions where the circumferential seam welded front section overlaps the longitudinal Argon weld; use a X5 magnifying glass.

Dimensional checks

With the spigot of the outer cone front flange mounted on parallel precision blocks, use a dial indicator to check the front flange attachment lugs for dishing; this must not exceed 0.030in. from the inner to outer edge of the lug.

Check the outer cone front flange for ovality, using a vernier calliper gauge; ovality is acceptable provided it does not exceed 0.100in.

Using a vernier calliper gauge, check the concentricity of the inner cone in relation to the locating diameter of the spigot on the outer cone front flange. To make this check, temporarily secure the inner cone in its normal position. Ensure that the outer leg of the vernier is positioned on the outer diameter of the spigot on the outer cone, and that the inner leg of the vernier bears on the outer diameter of the inner cone. The total eccentricity, as determined from a series of measurements across the annular gap, must not be greater than 0.100in.

Rebuild

Rebuild the exhaust unit as follows:

Stand the outer cone on its rear end and lower the inner cone into position, insulation plate uppermost. Align the tapped bosses on each of the inner cone support struts with the setscrew holes in the outer cone.

Lubricate the threads with graphited grease (89-1), then screw in the six $^5/16$in. setscrews and tabwashers to secure the outer cone to the inner cone support struts.

Ascertain the amount of 'drop' of the inner cone by placing a straightedge across the front face of the outer cone spigot and, with a depth gauge, measure:

Maintenance practices (cont.)

(a) The depth of the securing flange joint face on the outer cone.

(b) The depth of the insulation plate rim on the inner cone.

Subtract (a) from (b) to ascertain the drop from the outer cone flange to the rim of the insulation plate. This drop must be 0.730 to 0.840in. to ensure the correct clearance between the inner cone rim and the L.P. turbine disc. Where the drop is less than the lower limit, the surplus metal may be dressed back by hand to obtain the required figure, provided the weld will not be affected.

Finally, ensure that the six ^{5}/16in. setscrews are torque tightened (see 89-3), and securely locked by the tabwashers.

Repair

Return to an approved overhaul base for repair any exhaust units which do not comply with the above or which have unacceptable cracking.

NOTE: It is essential that when an exhaust unit is returned for overhaul a label is attached giving details of total hours run since new or since last overhaul.

DESCRIPTION

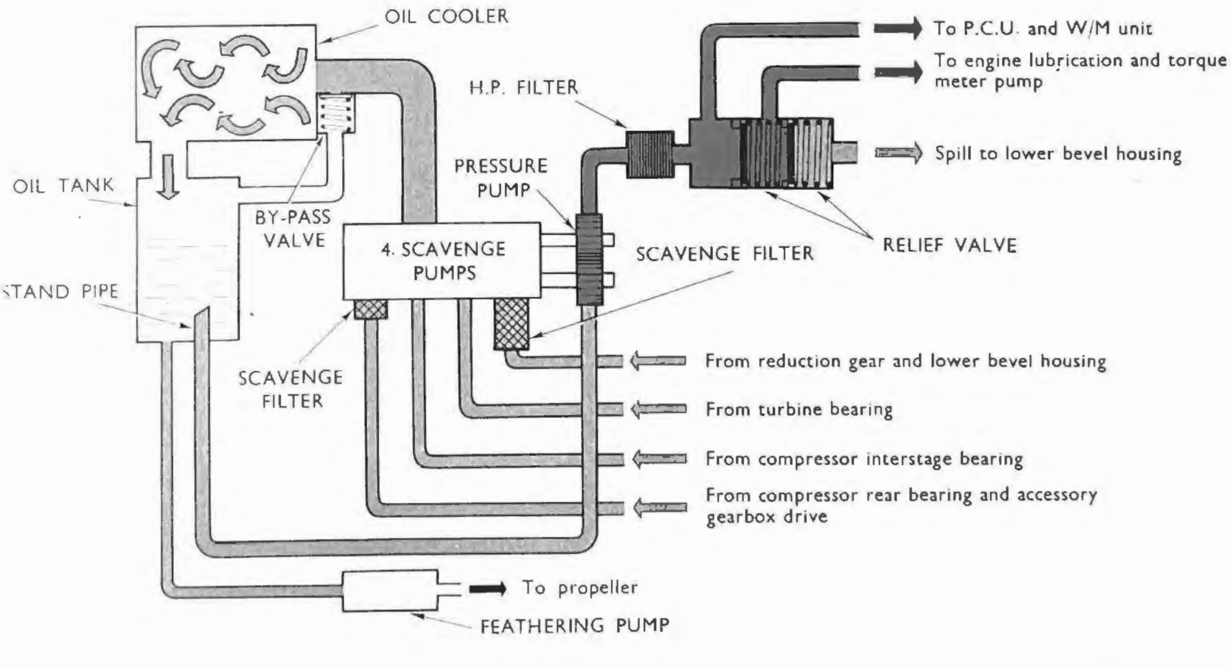
OIL SYSTEM

The Dart dry sump oil system (fig. 1) is completely self-contained on the engine. Oil is supplied from the annular oil tank to one pressure pump and is returned through an oil cooler by four scavenge pumps. The oil pump unit is illustrated in fig. 2. In addition to lubricating the engine, oil is supplied to operate the propeller and its control unit, the torque meter, and the water/methanol unit.

LUBRICATION CIRCUIT

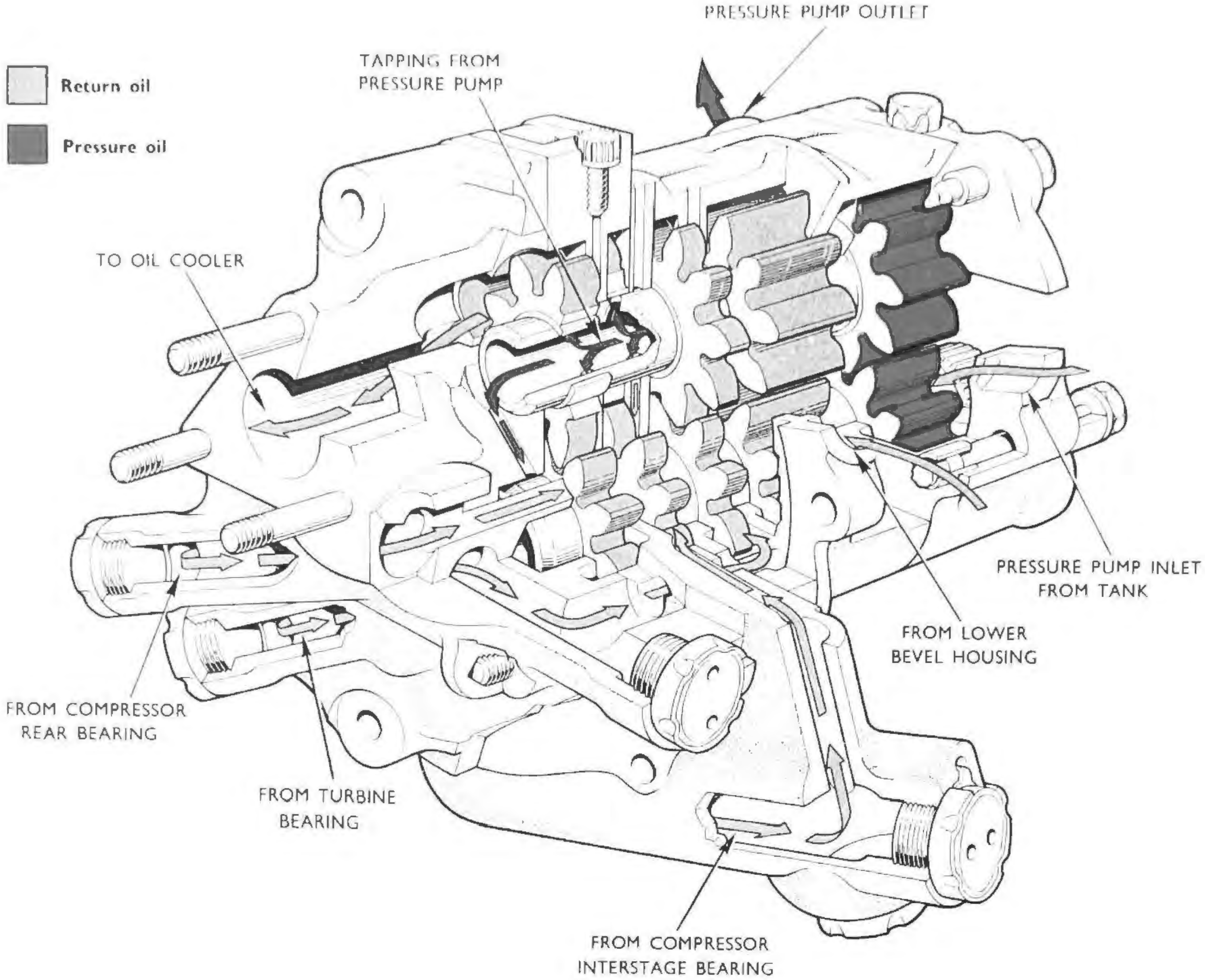
Oil is supplied through a stand-pipe in the base of the oil tank to the high pressure oil pump. The oil below the mouth of the stand-pipe, about 1 gallon, is supplied to the feathering pump and forms a reserve sufficient for at least two complete feathering operations.

Oil from the pressure pump passes through a high capacity pressure filter containing a single wire-wound element, the keystone section of the wire providing edge filtration. A by-pass valve which is spring-loaded to operate at a pressure difference of 40 lb. per sq. in. across the filter protects the engine from oil starvation in the event of filter blockage.


OIL COOLER
H.P. FILTER
To P.C.U. and W/M unit
To engine lubrication and torque meter pump
Spill to lower bevel housing
OIL TANK
PRESSURE PUMP
BY-PASS VALVE
4. SCAVENGE PUMPS
SCAVENGE FILTER
RELIEF VALVE
STAND PIPE
SCAVENGE FILTER
From reduction gear and lower bevel housing
From turbine bearing
From compressor interstage bearing
From compressor rear bearing and accessory gearbox drive
To propeller
FEATHERING PUMP

1988

Fig. 1 Oil system diagram


Return oil
Pressure oil
PRESSURE PUMP OUTLET
TAPPING FROM PRESSURE PUMP
TO OIL COOLER
PRESSURE PUMP INLET FROM TANK
FROM LOWER BEVEL HOUSING
FROM COMPRESSOR REAR BEARING
FROM TURBINE BEARING
FROM COMPRESSOR INTERSTAGE BEARING

2680

The pressures at which oil is delivered to the various points throughout the engine are controlled by a pressure relief valve assembly (fig. 3) integral with the oil filter housing and positioned at the filter outlet. The assembly consists of two pressure chambers formed by a pair of non-return disc valves arranged in series, both discs being spring-loaded to a nominal 35 lb. per sq. in.

Oil initially delivered to the upper chamber is allowed, by the first disc valve, to relieve into the lower chamber when the pressure difference between the two chambers exceeds 35 lb. per sq. in. This disc valve, controlling the upper or high pressure chamber, is therefore hydraulically uprated by the oil pressure existing in the lower chamber. The second disc valve controls pressure in the lower chamber at a maximum of 35 lb. per sq. in.; any pressure in excess of this is relieved past the disc to spill into the lower bevel housing. A small drilling in the relief valve cage by-passes the high pressure valve and provides a positive air bleed from the pump delivery line to assist pressure build-up on starting.

Oil tapped from the upper chamber of the pressure relief valve is supplied, at a controlled maximum of 70 p.s.i., to the propeller controller and the water/methanol unit. Oil from the lower chamber, controlled to a maximum of 35 p.s.i., supplies the engine lubrication system and torque meter pump and is connected through a pressure tapping to the electrical oil pressure transmitter. A low pressure warning device is also incorporated which illuminates a cockpit warning light whenever engine oil pressure is below a predetermined value.

Engine lubricating oil is delivered through jets to the compressor and turbine bearings, and to the reduction gear high speed pinion and layshafts, as shown in fig. 5.

Oil tappings are taken from the main supply line to lubricate the plain bearings in the lower bevel housing, and the drive train to the breather and accessory gearbox.

A fluted thread-type filter is housed in the delivery line to each of the main bearing jets, and a thread filter and wire mesh filter protect the jets in the reduction gear and the torque meter system.

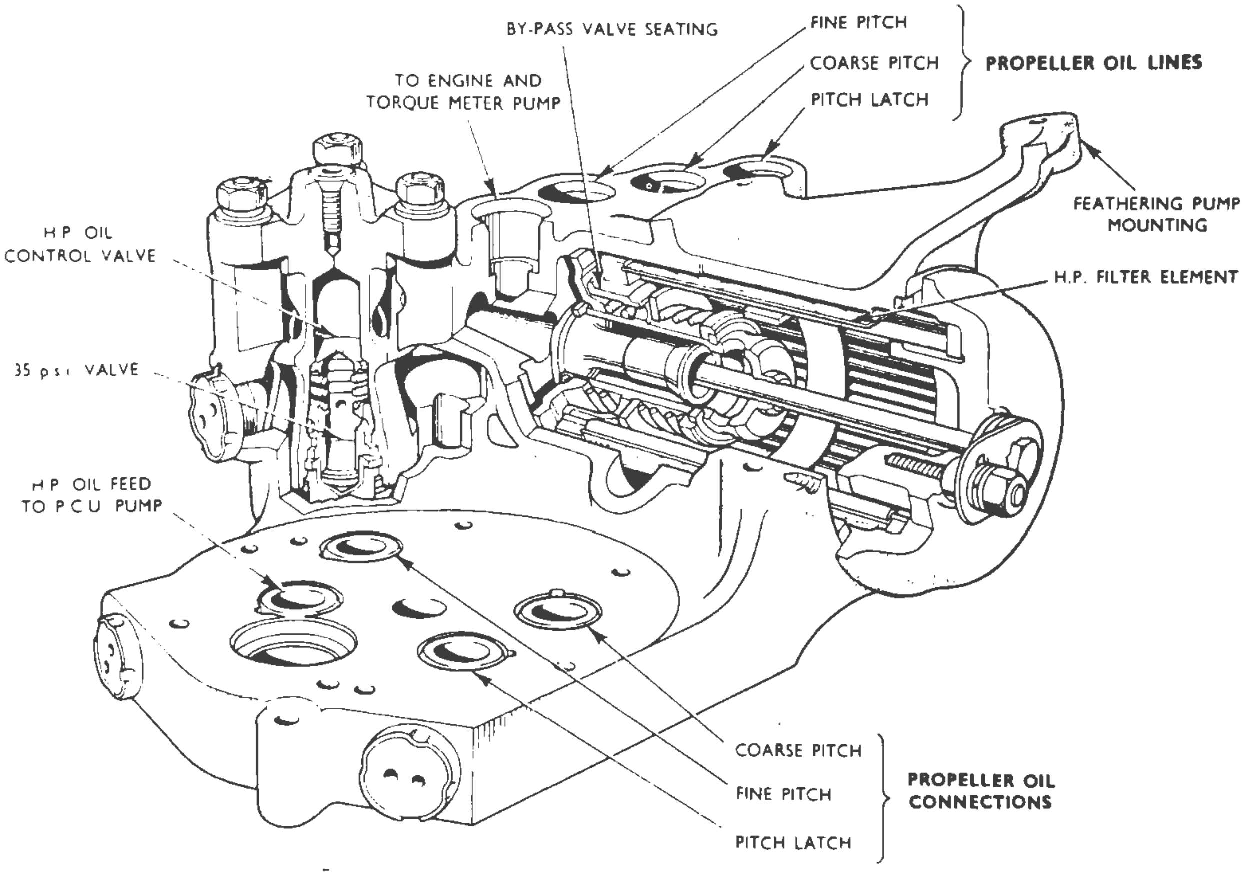


Fig. 3. Pressure oil filter and relief valve

Scavenge oil from the main bearings, accessory gearbox drives and reduction gear is returned by the scavenge pumps through a common delivery line to the oil cooler.

Both the front and rear scavenge pumps deal with oil that has lubricated plain bearings and are consequently each protected by a scavenge filter; these filters are housed in the base of the air intake casing. The one on the starboard side filters oil from the compressor rear bearing and the accessory gearbox drive, and the port filter deals with oil from the reduction gear and lower bevel housing.

To obtain the maximum cooling effect, oil flow though the cooler (fig. 6) is directed, by a series of baffles across the matrix, to pass radially inwards and outwards along the cooler against the flow of cooling air.

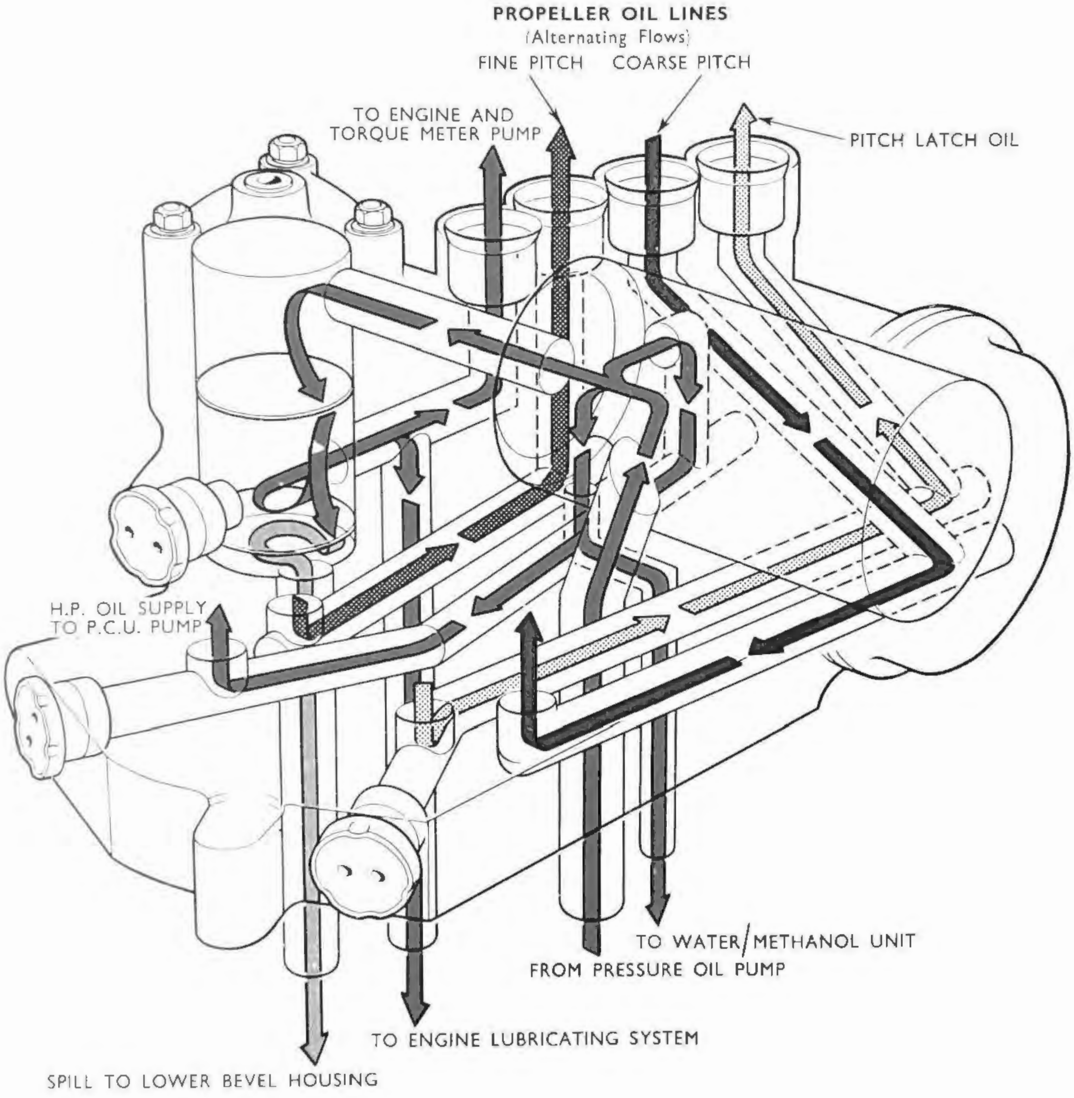


Fig. 4 Oil flow diagram—Pressure filter and relief valve

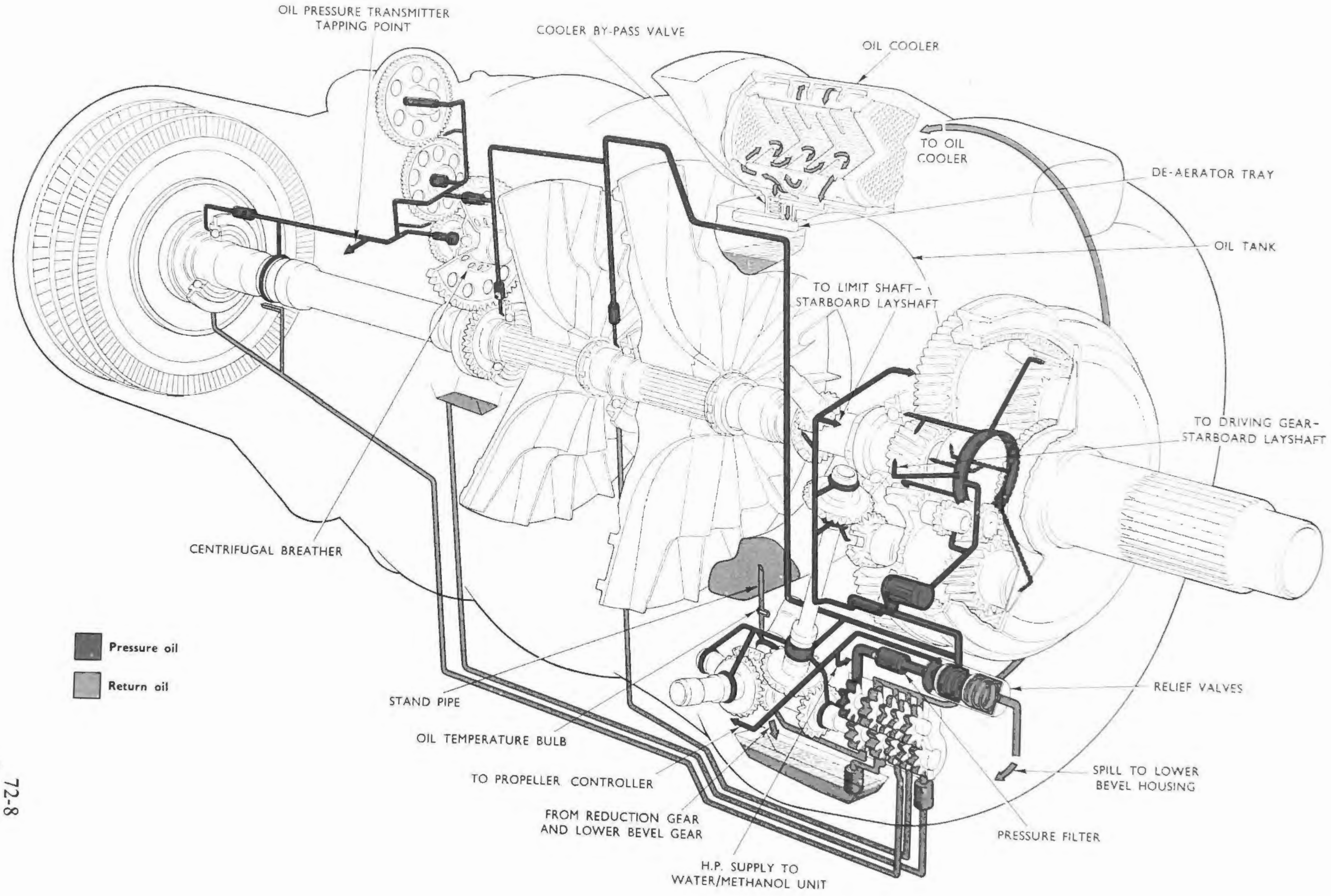

OIL PRESSURE TRANSMITTER TAPPING POINT
COOLER BY-PASS VALVE
OIL COOLER
TO OIL COOLER
DE-AERATOR TRAY
OIL TANK
TO LIMIT SHAFT-STARBOARD LAYSHAFT
TO DRIVING GEAR-STARBOARD LAYSHAFT
CENTRIFUGAL BREATHER
▇ Pressure oil
▨ Return oil
RELIEF VALVES
STAND PIPE
OIL TEMPERATURE BULB
TO PROPELLER CONTROLLER
SPILL TO LOWER BEVEL HOUSING
FROM REDUCTION GEAR AND LOWER BEVEL GEAR
PRESSURE FILTER
H.P. SUPPLY TO WATER/METHANOL UNIT

Fig. 5 Oil circulation diagram

2771A

A spring-loaded by-pass valve, connected across the cooler inlet and outlet by an annular helical passage, lifts at 30-35 lb. per sq. in. and protects the matrix from excessive pressure build up due to high viscosity during cold starting. The helical passage provides a heating jacket for the low temperature oil round the tubes; this ensures a quick reduction in the oil cooler back pressure.

The oil cooler discharges into the oil tank, where the oil is received in a funnel and directed over a de-aerator tray which spreads it out thinly to permit easy release of included air. The de-aerator tray also acts as a hot-well to maintain the hottest oil in circulation during cold starting. To prevent pressure build up, the tank is vented by a drilling through the air intake casing to the reduction gear casing, which in turn connects to the centrifugal breather.

The oil tank filler assembly, situated on the port side of the air intake casing, consists of a filler cap surrounded by an anti-spillage lip, a dipstick and an internally fitted filter assembly. The upper section of the filter prevents entry of foreign particles whilst filling the tank, the lower section filters oil entering the oil tank lower compartment.

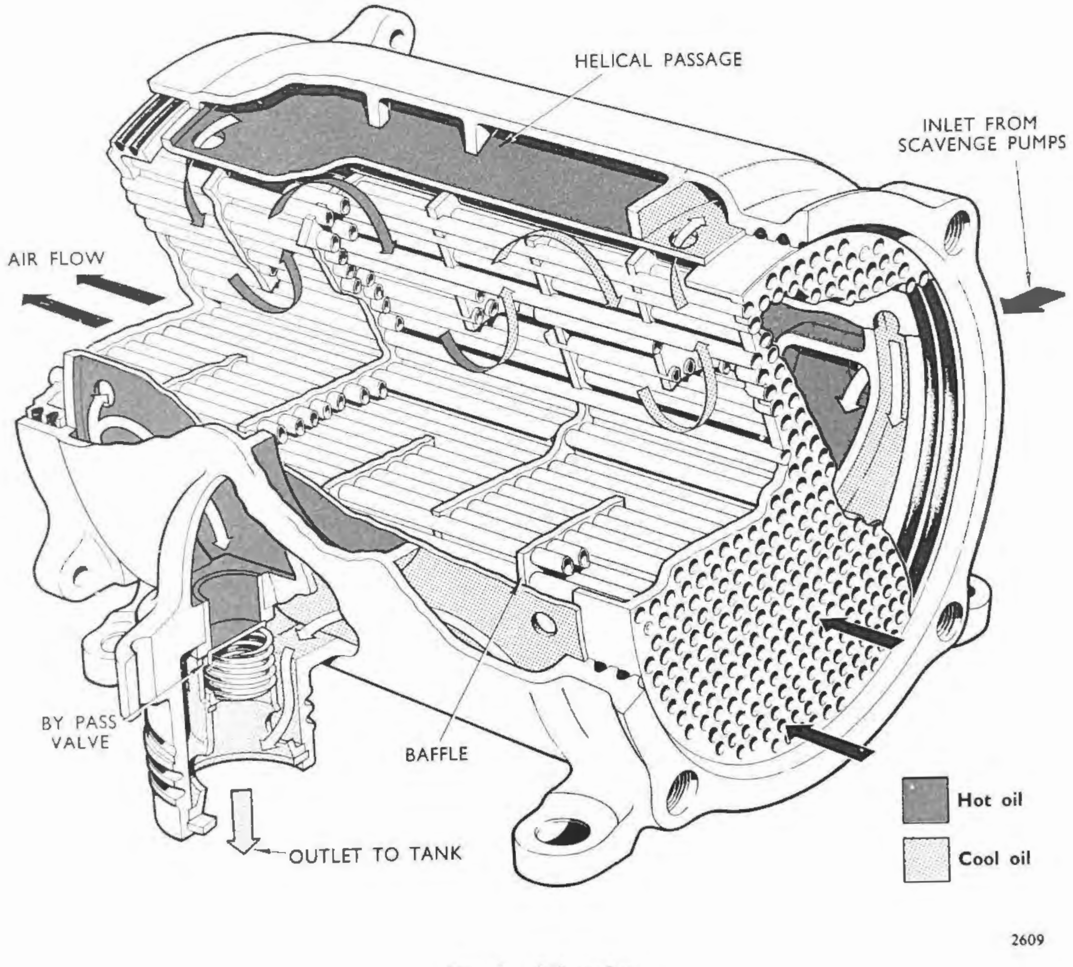


Fig. 6 Oil cooler

PROPELLER PITCH-CHANGE OIL CIRCUIT

The high pressure oil supplied from the pressure filter to the propeller controller unit, through drillings in the controller mounting pad, is boosted to an increased pressure by the controller unit pump and directed by a piston valve through further drillings in the pad to the coarse or fine pitch lines supplying oil to the propeller pitch change mechanism. Each line carries the pitch change oil as required or accepts the return oil displaced by movement of the propeller piston for recirculation through the controller unit.

An additional passage is provided to carry high pressure oil from the controller unit to the pitch latch mechanism in the propeller. The pitch change and pitch latch oil is transmitted by drilled passages in the air intake casing and reduction gear to the propeller shaft; here spring-loaded sealing bushes transfer the separate flows to the appropriate oil tubes, concentrically arranged, in the shaft.

Oil from the feathering pump is delivered through the propeller controller unit to the propeller shaft along the passages used for normal pitch-change operation.

WATER/METHANOL UNIT OIL CIRCUIT

The water methanol unit is supplied with oil at two pressures. Oil at torque meter pressure is transmitted as previously described, and engine oil at a controlled maximum of 70 lb. per sq. in. is supplied from the high pressure filter to the water/methanol unit through cored passages around the air intake casing; return oil from the unit is ducted direct to the top of the oil tank.

BREATHER

To prevent pressure build-up due to ingress of pressurizing air through the bearing labyrinth seals, the oil tank and all lubricated compartments in the engine are vented to atmosphere through a centrifugal breather constructed to allow free passage of air without loss of oil.

The focal point of pressure release from the compartments at the front and rear of the engine is around the centre coupling, where the air from the turbine bearing is joined by air from the compressor rear bearing and that flowing along the hollow compressor shaft and reduction gear drive shaft. This latter air is a flow vented from the compressor interstage bearing and from the reduction gear, into which the oil tank and lower bevel housing are vented.

From the centre coupling the air flows into the centrifugal breather housing where it is joined by air from the accessory gearbox drive housing.

The centrifugal breather is a rotor, driven by a gear wheel bolted to the second-stage impeller shaft. The oil, flung outwards, is prevented from passing into the breather outlet passages by curved vanes and flanges which mate with lips on the casing. The air is directed inwards through holes in the rotor and passed outwards to atmosphere through a large diameter pipe on the port side of the accessory gearbox drive.

OIL SYSTEM - MAINTENANCE PRACTICES

1. Filling the oil tank

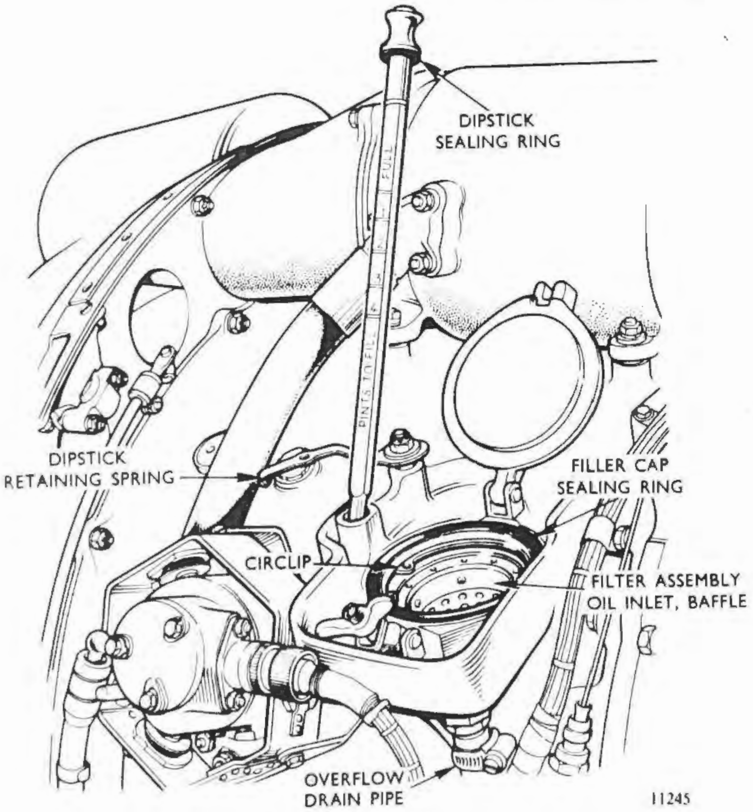
A. General

WARNING: THE SYNTHETIC LUBRICATING OIL USED IN THIS ENGINE CONTAINS ADDITIVES WHICH, IF ALLOWED TO CONTACT THE SKIN FOR PROLONGED PERIODS, CAN BE TOXIC THROUGH SKIN ABSORPTION.

CAUTION: 1. THE OIL SPECIFIED FOR USE IN THE OIL SYSTEM IS A SYNTHETIC PRODUCT AND MUST NOT BE MIXED WITH ANY OTHER OIL. IT IS INJURIOUS TO PAINT WORK AND CERTAIN TYPES OF RUBBER AND MUST NOT BE ALLOWED TO CONTAMINATE THOSE PARTS OF THE ENGINE NOT NORMALLY IN CONTACT WITH IT. ANY OIL SPILT DURING SERVICING MUST BE WIPED UP IMMEDIATELY.

2. COMPLETE BREAKDOWN OF THE ENGINE SYNTHETIC OIL CAN BE CAUSED THROUGH CONTAMINATION BY THE AMOUNT OF CERTAIN ALKALINE CLEANERS THAT CAN CLING TO THE WALLS OF A NOMINALLY EMPTY CONTAINER. EXTREME CARE MUST THEREFORE BE EXERCISED TO PREVENT ALKALINE CLEANERS FROM COMING INTO CONTACT WITH THE OIL DIRECTLY OR INDIRECTLY, e.g. BY THE INDISCRIMINATE USE OF CANS OR CONTAINERS.

The overflow tray should be kept clean at all times to avoid the risk of foreign matter entering the oil tank when the filler cap is open: the drain pipe from the overflow tray should be kept clear of obstruction. The condition of the rubber sealing rings on the filler cap and dipstick (fig.201) should be checked and renewed as necessary. Before topping up, the oil inlet baffle should be visually checked for obstruction.



Typical oil tank filler and dipstick
Fig.201

Oil system - Maintenance practices (cont.)

Careful measurement should be made of the amount of oil added so that accurate oil consumption records may be kept. If abnormal oil consumption is noted in service, action must be taken as described in 'Trouble shooting, Engine, Oil system defects'.

To ensure stabilized conditions and consistent results, the check of the oil level in the tank and any topping up required should be carried out between 10 and 30 minutes after shut-down. This procedure will obviate over or under-filling and will facilitate accurate recording of oil consumption.

If an operational quick turn-round (within 10 minutes from shut-down) is required, proceed as given in (C).

B. Turn-round (between 10 and 30 minutes after shut-down)

(1) Top up to FULL.

C. Operational quick turn-round (within 10 minutes from shut-down)

(1) Oil level within 2 pints from FULL.

(a) No action.

(2) Oil level lower than 2 pints from FULL.

(a) Top up to FULL.

NOTE: DELETED

D. Engine out of service or standing idle for a period

(1) Oil level not lower than 4 Imperial (5 U.S.) pints from FULL.

CAUTION: THIS IS THE MINIMUM OIL LEVEL REQUIRED BEFORE OPENING UP THE ENGINE ABOVE 11,000 R.P.M.

(a) Ground run the engine for 10 minutes at 11,000 r.p.m. then top up as above.

NOTE: If required, the engine can be run over the full power range.

(2) Oil level lower than 4 Imperial (5 U.S.) pints from FULL but showing on calibration flat of dipstick.

(a) Motor the engine for 30 seconds ensuring that pressure is recorded on the gauge.

(b) Ground run for 10 minutes at 11,000 r.p.m. and top up as above.

CAUTION: OBSERVE PRESSURE GAUGE CONSTANTLY DURING RUN. SHUT DOWN IMMEDIATELY IF PRESSURE FALLS OR FLUCTUATES.

(3) Oil level not showing on flat of dipstick.

(a) Check the level on the oil tank baffle.

(b) If level within 10in. from top of baffle motor the engine for 30 seconds. Provided a pressure is shown on the gauge and oil is now showing on the flat of the dipstick, ground run and top up as above.

(c) If no pressure is shown during 30 seconds motoring or oil is not shown on the dipstick proceed as given in (4).

(4) Oil level not within 10in. of top of baffle

(a) Drain the sump by removing both scavenge filters.

(b) Replace both scavenge filters.

(c) Refill the tank to FULL.

(d) Run engine for 10 minutes and top up to FULL.

E. On installation

(1) Fit the propeller to the engine.

(2) Remove both scavenge filters and drain the sump (see 5A).

(3) Replace both scavenge filters.

(4) It is recommended that the special oil by-pass equipment HW.68267 should be fitted at this stage. Refer to 'Adjustment/Test, Engine'.

(5) Fill the oil tank to FULL and record the amount.

(6) Select H.P. cock FEATHER and operate the feathering control for 5 seconds maximum.

(7) Select H.P. cock SHUT (single lock propellers) EMER. OUT, CRUISER LOCK OUT or LOCK OUT (2 lock) and unfeather the propeller to its ground fine pitch stop.

(8) Select H.P. cock SHUT, CLOSED OR FUEL OFF (2 lock only).

(9) Add a further 10 pints.

(10) Motor the engine for 30 seconds. Check that there is movement of the oil pressure gauge.

Oil system - Maintenance practices (cont.)

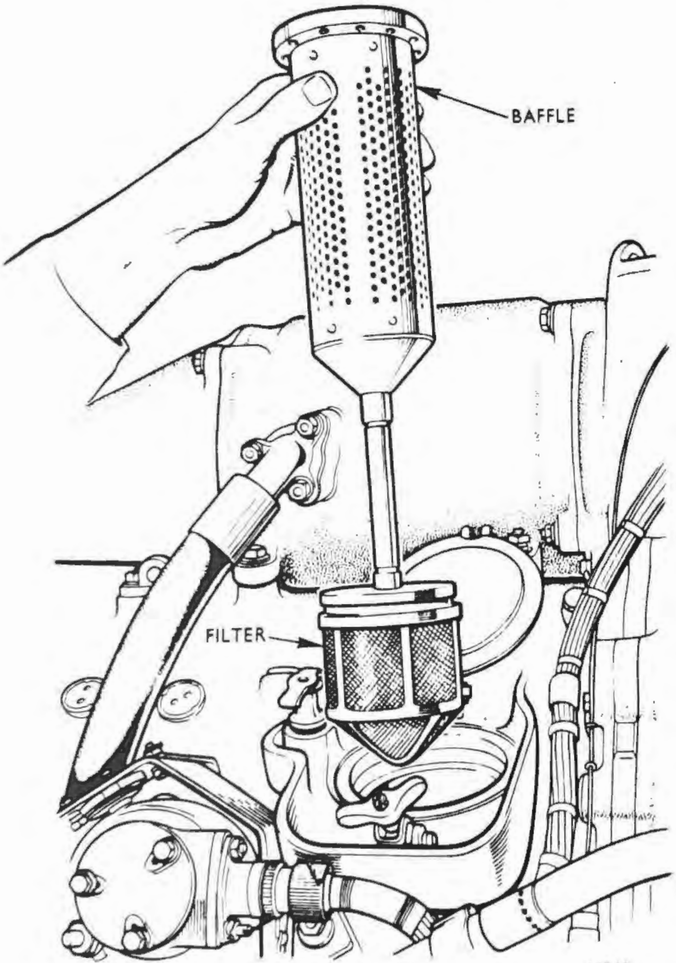
(11) Carry out propeller system functional checks (Engine, Adjustment/test) and check the oil level in accordance with D.(1), (2) or (3).

NOTE: When carrying out the initial ground running, after installation and before completing the engine serviceability checks, move the throttle lever slowly backward and forward into the cruising range several times before opening up fully. This will ensure that the propeller oil system is freed from air.

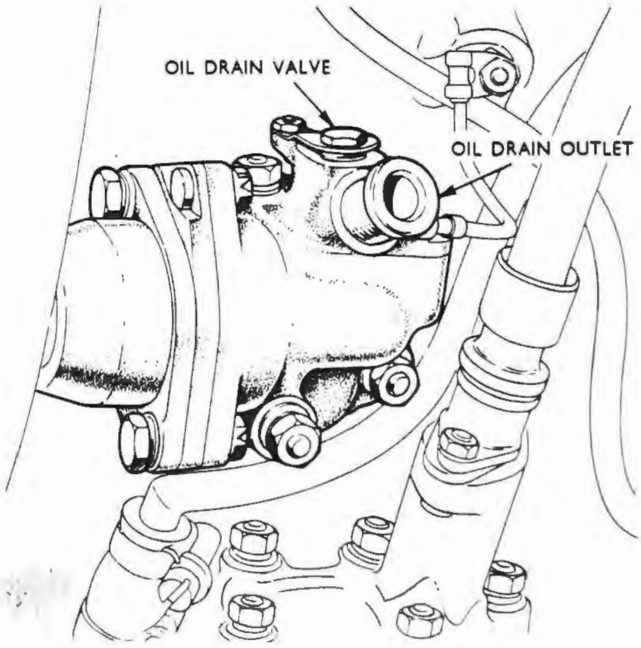
2. Cleaning the filter assembly

A. The oil tank filler tray and filter are designed to maintain cleanliness during filling and topping-up operations; if the filler tray becomes dirty, clean it before pouring any oil into the tank.

NOTE: The filter itself may be removed for cleaning by removing the circlip retaining the filter assembly in the tank orifice and withdrawing the complete assembly (fig.202).



Oil tank filter
Fig.202



Oil tank drain
Fig.203

Oil system - Maintenance practices (cont.)

3. Draining the oil tank

A. Attach a drain hose to the nozzle (fig.203) and unscrew the adjoining valve to permit the oil to flow out.

NOTE: Should the engine oil system be drained and refilled for any reason, ensure the propeller feathering oil system is functioning satisfactorily by carrying out a propeller feathering/unfeathering check.

4. Removal/Installation - pressure filter

A. Remove the pressure filter

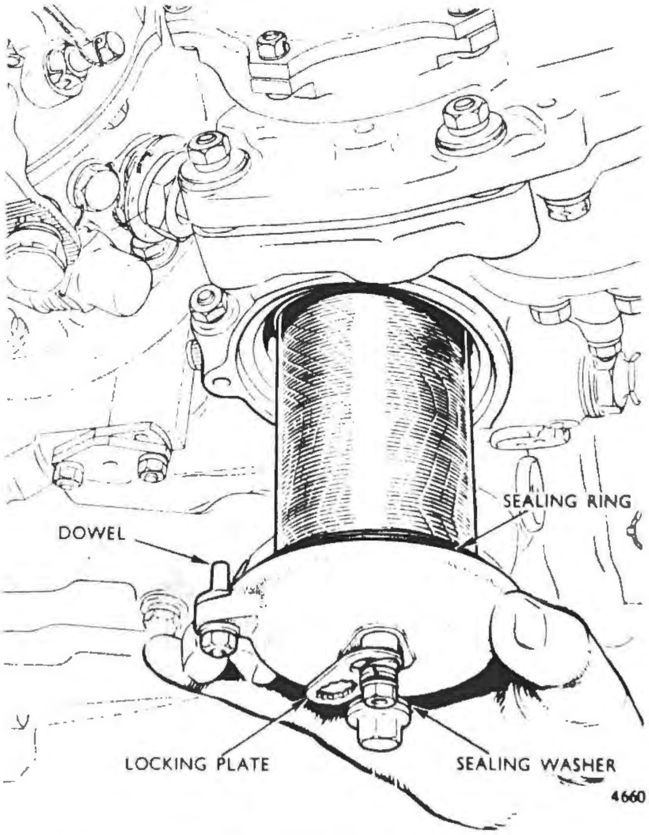
(1) Slacken the nut securing the retaining bolt locking plate allowing the plate to fall clear of the bolt.

(2) Slacken the filter retaining bolt and allow the filter to drain.

(3) Unscrew the bolt and withdraw the cover and filter assembly (fig.204).

B. Install the pressure filter

(1) Clean the joint faces of the cover and casing. Check the condition of the sealing washers between the cover plate and filter body and the cover plate and bolt head; renew as necessary.



Removal of pressure oil filter
Fig.204

Oil system - Maintenance practices (cont.)

3. Draining the oil tank

A. Attach a drain hose to the nozzle (fig.203) and unscrew the adjoining valve to permit the oil to flow out.

NOTE: Should the engine oil system be drained and refilled for any reason, ensure the propeller feathering oil system is functioning satisfactorily by carrying out a propeller feathering/unfeathering check.

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4. Removal/Installation - pressure filter

A. Remove the pressure filter

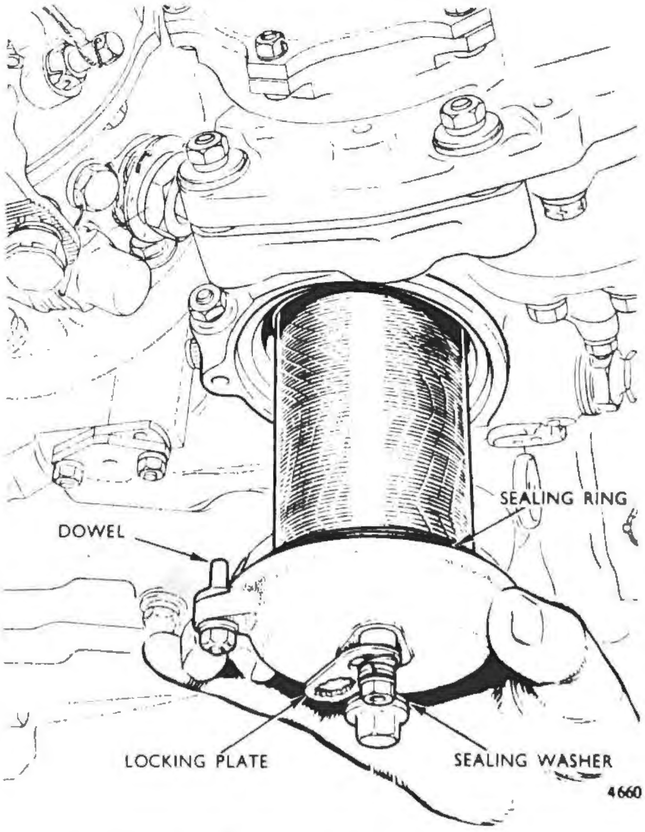
(1) Slacken the nut securing the retaining bolt locking plate allowing the plate to fall clear of the bolt.

(2) Slacken the filter retaining bolt and allow the filter to drain.

(3) Unscrew the bolt and withdraw the cover and filter assembly (fig.204).

B. Install the pressure filter

(1) Clean the joint faces of the cover and casing. Check the condition of the sealing washers between the cover plate and filter body and the cover plate and bolt head; renew as necessary.



Removal of pressure oil filter
Fig.204

NOTE: Renewal of the sealing washers will necessitate dismantling the filter assembly.

To dismantle the pressure filter assembly, withdraw the filter element, engage the bolt in the captive thread in the filter relief valve assembly, and screw out the bolt. Withdraw the bolt from the relief valve locating spring and cover.

(2) Wash the filter assembly in clean kerosine; if the engine is not to be run immediately, immerse the assembly in clean engine oil before replacement.

(3) Replace the filter assembly, ensuring that the dowel pin on the cover is aligned with the hole in the casing.

(4) Tighten the retaining bolt to the torque loading given in 'Torque loading data' (Torque tightening procedure for specific items).

(5) Refit the lockplate and retaining nut.

(6) Top up the oil tank as described in this page block, run the engine and check for leaks.

5. Removal/Installation - scavenge filter

A. Remove the scavenge oil filter

(1) Slacken the nut securing the retaining bolt locking plate.

(2) Slacken the filter retaining bolt and allow the filter to drain.

(3) Unscrew the bolt and withdraw the cover and filter assembly (fig.205).

B. Install the scavenge filter

(1) Clean the joint faces of the cover and casing. Check the condition of the sealing washers between the cover plate and filter body, and the cover plate and bolt head; renew as necessary.

NOTE: Renewal of the washers will necessitate dismantling the filter assembly.

To dismantle a scavenge filter assembly, remove the circlip securing the retaining plate to the central bolt and slide the plate, filter and cover from the bolt.

(2) Wash the filter assemblies in clean kerosine; if the engine is not to be run immediately, immerse the assembly in clean engine oil before replacement.

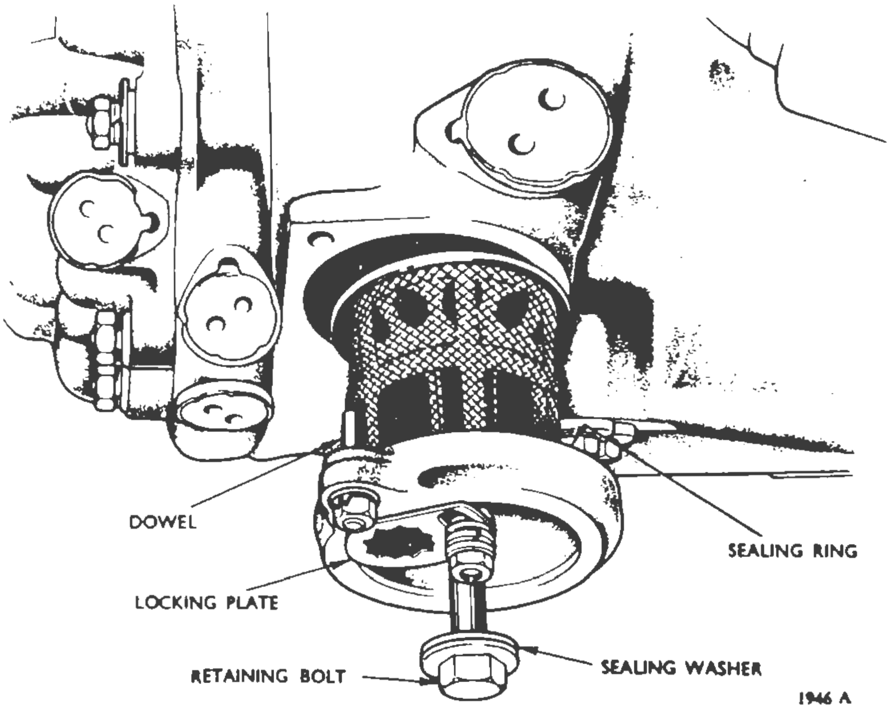
Oil system - Maintenance Practices (cont.)

(3) Replace the filter assembly, ensuring that the dowel pin on the cover is aligned with the hole in the casing.

(4) Tighten the retaining bolt to the torque loading given in 'Torque loading data' (Torque tightening procedure for specific items).

(5) Refit the lockplate and retaining nut.

(6) Top up the oil tank, run the engine and check for leaks.



Removal of scavenge oil filter
Fig.205

6. Removal/Installation - oil pressure relief valve

A. Remove the oil pressure relief valve

(1) Remove the propeller controller unit (61-1).

(2) Remove the two nuts securing the flange.

(3) Screw the withdrawal tool HW.68320 into the central thread provided in the cover.

Oil system - Maintenance Practices (cont.)

(4) Use the tool as a captive hammer and withdraw the assembly from its housing.

B. Install the oil pressure relief valve

(1) Renew the rubber sealing ring and smear the exposed sliding surface of the ring with clean engine oil.

(2) Insert the assembly into the housing and secure with the nuts and washers.

7. Removal/Installation - oil cooler

A. Remove the cooler

(1) Disconnect the electrical harness clips from the cooler and the compressor casing to obtain sufficient clearance between the harness and the cooler to enable the cooler to be removed.

(2) Remove the three nuts securing the scavenge oil return pipe to the cooler.

(3) Remove the pipe.

(4) Remove the four setscrews securing the air inlet casing to the cooler.

(5) Remove the four nuts securing the cooler to the air intake casing (fig.206).

(6) Using the tool HW.37000 to free the oil outlet connection rubbers on the right-hand side of the cooler, lift the cooler upwards and rearwards complete with the air outlet casing which can then be removed if required.

B. Install the cooler

(1) Fit the air outlet casing.

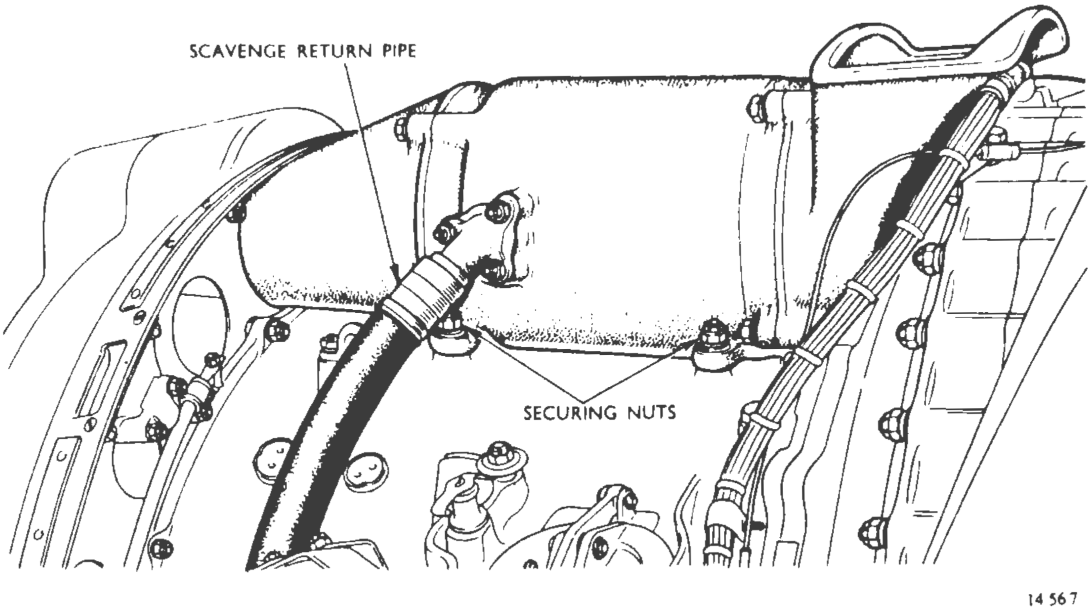
(2) Fit new rubber seals to the oil outlet transfer pipe.

(3) Place the cooler air inlet casing in position against the air intake cowling backplate and secure the cooler on the rubber mountings with the four nuts.

(4) Secure the air inlet casing to the cooler with four setscrews.

(5) Fit a new joint packing to the scavenge oil pipe elbow and secure it to the cooler with three nuts.

(6) Connect the electrical harness to the cooler and the compressor casing.



Oil cooler connection points
Fig.206

8. Adjustment/Test

A. Oil system

(1) Replenish the oil system as described in this page block.

(2) Ground run the engine and check the oil pressure as described in 71-0, 'Power plant Adjustment/test'.

(3) Examine the units, on which work has been carried out, for oil leakage.

(4) Replenish the oil system as described in this page block.

B. Pressure test the oil cooler

(1) Refer to '12. Inspection/Check - Oil cooler'.

(2) Fit the blanking tackle J.55984 to the cooler, using slave sealing rubbers on the outlet elbow of the outer casing.

(3) Attach an air pressure line to the pressure inlet connection of the blanking tackle and apply a pressure of 10 p.s.i.

(4) Immerse the assembly in water of a temperature between 30 and 40 deg.C. (86 to 104 deg.F.), then raise the pressure to 70 p.s.i. Maintain the pressure for 5 minutes; reject the oil cooler if any leaks are apparent during this period. On completion of test lower the pressure to 10 p.s.i. and remove the assembly from the water.

NOTE: The reason for applying the low pressure during immersion and removal from the water is to prevent the ingress of water resulting from an incorrectly fitted or defective pressure blank.

(5) Release the pressure.

(6) Completely dry off the exterior of the cooler with compressed air before detaching the pressure test tackle.

9. Inspection/Check - General

If abnormal oil consumption is noted during service, visually examine the oil system for signs of external leakage, particularly in the vicinity of pipe joints and component joint washers. Refer to 'Trouble Shooting, Engine, Oil system defects'.

10. Inspection/Check - Oil filters

The presence of metallic particles in the filters may not necessarily indicate internal failure, particularly if the engine is in the early part of its life and the particles are of light alloy. Great care should therefore be taken to establish the identity of the metal by chemical or mechanical means before rejecting the engine as unserviceable. Metal found in the pressure filter will need very careful examination but that found in the scavenge filters will be more readily identifiable by reason of its size.

When engines are rejected for supected failure following the discovery of metal particles in the filters, the metal, however small in quantity, should be wrapped and labelled and returned with the engine.

Remove each filter separately and allow the oil to drain into a clean container. Fine particles in the residue from the drained oil are acceptable, but investigate any water content in the oil and if the quantity is more than a few drops replenish the oil system and ground run the engine for 5 minutes to boil off any water remaining. The next flight may serve this purpose provided it takes place within a few hours; otherwise internal corrosion may result.

A. Pressure filter

(1) Examine the filter and the recesses in the filter cover for metal particles; if any are found, strain the oil drained from the filter through a fine mesh gauze or cloth of finer mesh than the filter to provide further evidence.

(2) Gently rinse the filter element in clean kerosine and inspect the oil residue.

On the pressure filter, small amounts of light alloy are permissible but coarse particles of bronze or steel are unaccepaable. If fine bronze or steel particles are present, however, and the checks of the scavenge filters and the oil residue are satisfactory, the filters must be cleaned and replaced, the oil system refilled and a further check made after a 10 minute ground run over the speed range including 1 minute at maximum r.p.m.

A block sooty deposit on the pressure filter element may indicate that the starter clutch friction plates are in an advanced stage of wear. The material worn from the plates enters the oil system and whenever a sooty deposit is found on the pressure filter the starter drive assembly should be examined for signs of black sludge indicating clutch wear. If clutch wear is apparent, the following action is to be taken:

(a) Change the starter drive assembly (80-1)

(b) Clean all traces of black sludge from the starter drive assembly housing

(c) Drain and refill the oil system

(d) Re-examine the oil pressure filter element at the next convenient servicing period or within 10 flying hours.

B. Scavenge filter

If inspection of the scavenge filter reveals isolated turnings of aluminum, magnesium, or small shreds of rubber or fluff, these are acceptable, but any other metal fragments, or portions of rubber which can be identified as parts of a rubber sealing ring, will necessitate engine replacement.

11. Inspection/Check - Oil pressure relief valve

A. Inspect the relief valve

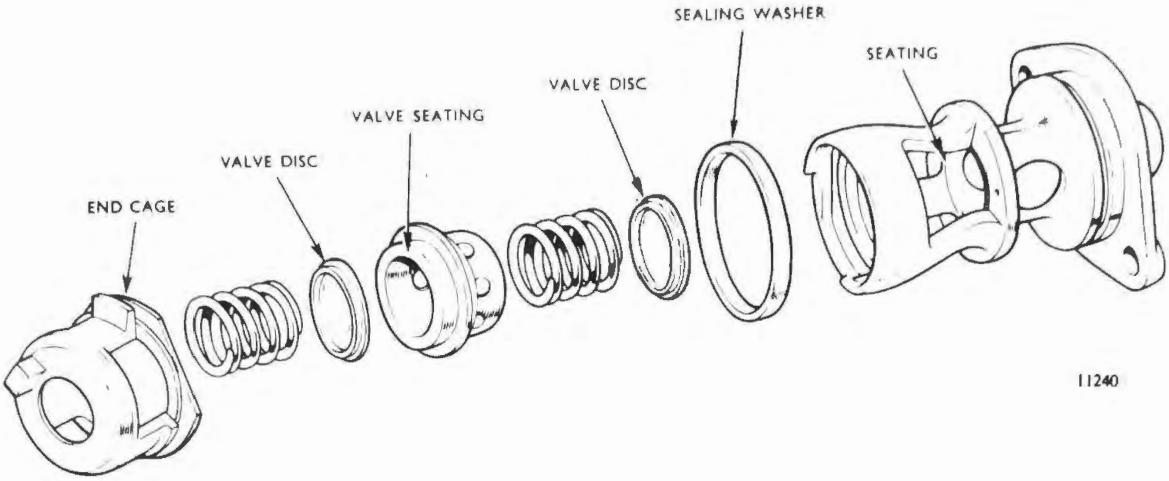
(1) Compress the relief valve springs by applying hand pressure to the inner end of the cage.

(2) Rotate the cage in an anti-clockwise direction, release the pressure and withdraw the parts (fig.207).

(3) The valve discs must not be interchanged.

(4) Wash the parts in kerosine and examine the discs and seatings.

(5) If necessary lap the discs and seatings together, using a fine abrasive, until a mirror finish is obtained.



Oil pressure relief valves
Fig.207

(6) Wash the parts in kerosine to remove all traces of abrasive.

(7) Dry the components and reassemble the valves into the cage and housing.

12. Inspection/Check - Oil cooler

A. Routine inspection

(1) Check the air passages for obstruction, using a light from the rear.

(2) Apply compressed air from the rear of the matrix to clear any obstruction.

NOTE: Slight damage to the matrix is acceptable provided it does not cause leakage or reduce the cooling area by more than 5 per cent.

(3) Change the cooler if there is evidence of oil having run from the drain hole and down the engine air intake casing.

B. Inspect the replacement cooler

If a replacement cooler is to be fitted, it must be confirmed that damage has not occurred to the unit in transit or that deterioration has not taken place after prolonged storage. The following action should therefore be taken.

(1) A pre-packed assembled cooler obtained from stores must be drained of inhibiting oil and pressure tested as described in 'Adjustment Test' this page block, before being fitted to the engine.

(2) An assembled cooler which has not been in transit but has been stored containing engine oil, may be fitted without further pressure testing provided it has been pressure tested during the previous three months. To prevent oil being spilt on the engine, it is recommended that the cooler be drained of spillable oil before being fitted.

(3) A cooler may be assembled from pre-packed parts, using new sealing rubbers, provided the assembled unit is pressure tested before being fitted to the engine; the sealing rubbers should be well lubricated to prevent them twisting during assembly. Drain the inhibiting oil.

(4) When draining inhibiting oil from the cooler it is important that no greater quantity of the oil should remain in the cooler than will inevitably adhere to the internal surfaces, as it does not mix satisfactorily with the synthetic oil used in the engine.

C. Inspect the relief valve

(1) Remove the circlip retaining the loading spring and valve disc.

(2) Withdraw the spring and valve disc.

(3) Examine the disc and seating face.

(4) Lap the disc to the seating if required, using a fine abrasive, until a smooth finish is obtained.

(5) Clean the parts thoroughly in kerosine and dry.

(6) Assemble the valve into the cooler.

13. Inspection/Check - oil pipes

A. Inspect rigid pipes

(1) Inspect all pipes and pipe connections for security, damage and chafing.

(2) Check all pipe clips, bonding leads and bonding lead lugs for security.

(3) Check all pipe connections for leakage.

NOTE: Leakage can be caused by malalignment or faulty sealing rings. Do not attempt to rectify malalignment until the pipe connections, keep plates and clips have been slackened.

B. Inspect flexible pipes

(1) Inspect all pipe end fittings for corrosion, security and signs of leakage.

(2) Check that the pipes are not cut or chafed where they pass through clips or close to any adjacent component.

(3) Inspect the pipes for signs of cracking or kinking.

NOTE: Abnormal conditions causing accelerated ageing may result in surface crazing consisting of numerous minute cracks. These, by themselves, do not make a pipe unserviceable, but a careful check should be made at regular intervals so that any development of the crack can be detected and the pipe replaced.

(4) Any pipe removed from an engine is to be cleaned and its serviceability assessed from the following inspection:

(a) Inspect the end fittings for corrosion. Inspect the union nuts, threads and lockwire holes for damage. Inspect the seating faces of the spherical or banjo connections for distortion, damage and any nipple spread; any scoring, damage or excessive nipple spread which may cause leakage, will entail rejection of the pipe.

(b) Pipes which have taken up a permanent set through incorrect assembly are unacceptable, spiralling of the identification markings is an indication that this has occurred.

(c) Pipes that show deterioration through being exposed to excessive heat conditions i.e., burning or blistering should be rejected. Surface crazing or cracks caused by high temperature conditions is acceptable provided the cotton braiding is not exposed.

(d) Softening or swelling of the pipe outer cover caused by oil contamination is acceptable provided the outer cover is not in a semi-plastic condition i.e., sticky to the touch, or the outer cover is not detached from the inner metallic braid. The latter would be indicated by a blistering affect.

(e) Pipe outer covers with identification tags and pipe location clips bedded into them are acceptable, but if the identification tag, when positioned in the area of bedding is below the outer cover surface, reject the pipe.

(f) Pipes that have been damaged by either cuts or nicks are acceptable provided the cotton braiding is not exposed.

NOTE: When assessing the severity of cuts or cracks in the outer cover, particular attention should be given to cuts of cracks occurring on bends in the installed positioned of the pipe, as damage of this nature in an area under bending stress can cause further deterioration of the pipe and expose the wire braid.

(g) Check the pipe for obstruction of the bore. On some pipes a visual examination can be made, but where angle fittings are used, or if the pipe is too long for visual examination of the bore, kerosine must be pumped through the pipe to ensure that a free flow is maintained. The kerosine should be adequately filtered before it is pumped through the pipe.

(h) Pressure test the pipe - see 'C. Pressure test flexible pipes'.

C. Pressure test flexible pipes

Before being fitted to an engine, new and replacement flexible pipes must be pressure tested, using appropriate equipment and blanks. Where no facilities for pressure testing exist, the pipe must be removed and tested at the first available apportunity. The table given below lists the pipes, together with their individual test pressures.

For pressures exceeding 75 p.s.i. the pipes should be tested hydraulically using kerosine or soluble oil in water. For pressures of 75 p.s.i. or less, clean dry air is used, with the pipe immersed in hot water at a minimum temperature of 60 degrees C. (140 degrees F.).

Test each pipe at the pressure specified, maintaining the pressure for a minimum period of 2 minutes during which time the pipe is to be flexed several times by hand through an angle of approximately 30 degrees. Any pipe which leaks is to be rejected.

PIPE	TEST PRESSURE p.s.i.
'WEATHERHEAD' or 'SILVOFLEX' hose	
Feathering pump to P.C.U.	1,100
Water/methanol unit to pressure transmitter	700
Scavenge pump to oil cooler	500
Oil pressure transmitter to bulkhead	500
Bulkhead to intermediate casing	500
'AVICA' or 'SUPER METALFLEX' hose	
Oil drain pipe, compressor casing	50

14. Oil filter housing insert replacement

Both the main scavenge and wheelcase scavenge oil filter housings contain a steel insert to accept the filter retaining bolt. Over-tightening the bolt

Oil system - Maintenance practices (cont.)

when refitting a scavenge filter can pull out the insert through stripping of the threads in the housing.

Should this occur, a replacement oversize insert may be fitted without removing the engine by carrying out the following procedure:

(1) Blank off all galleries and passages in the filter housing with adhesive tape or cardboard.

CAUTION: COTTON WASTE OR REMNANTS OF CLOTH MUST NOT BE USED.

(2) Fit the bush plate HW.33831 to the filter housing, ensuring that the flange of the bush plate seats squarely on the housing cover face.

(3) Ream out the existing threaded hole with the hand reamer HW.33832. Continue reaming until the tool contacts the bottom of the hole and no more metal is being cut.

(4) Remove the reamer and bush plate and extract all swarf and metal particles.

(5) Refit the bush plate and use the tap HW.33833 to produce a right-hand Whitworth Form thread 0.6225in. diameter, 20 t.p.i., to a full thread depth of 0.850 + 0.025in. The tap should be wound evenly in a clockwise direction only.

(6) Remove the tap and bush plate and extract all swarf and metal particles.

(7) Screw the pilot tool HC 41 into the tapped hole to a depth of approximately 0.500in. from the hole face, using the pilot key HC.546.

(8) Refit the bush plate.

(9) Set the coning cutter HW.33834 to the setting gauge HW.33835 and, using a tap wrench, produce the 60 deg. cone.

NOTE: The depth of the cone seating is determined by the setting gauge and should result in the insert projecting 0.025 - 0.005in.

The finish of the cone must be free from scoring and chatter marks.

(10) Remove the bush plate and pilot tool and clean out all swarf and metal particles from the filter housing.

(11) Fit the oversize insert, Part No. RK.19542, to the driver HC.9 and screw HC.8.

(12) Apply a small amount of engine oil or grease to the threads then screw the insert into the filter housing until the cone is seating firmly.

(13) Withdraw the screw and driver and remove all blanking material from the apertures in the filter housing. Replace the filter assembly as described earlier.

DESCRIPTION

COOLING AND SEALING AIR SYSTEM

Air is tapped from several points around the compressor and ducted to various parts of the engine to counteract the spread of heat from the main gas stream, to pressurize the labyrinth seals and the annular space formed by the compressor casings around the second stage inlet, to purge the water/methanol passages and to supply hot air for de-icing the fuel filter.

COOLING AIR

Low pressure cooling air is tapped through an annular slot in the first-stage compressor casing; a small proportion of this air flows through drillings to purge the water/methanol passages while the remainder is transferred through an external pipe to the intermediate casing, where it cools and pressurizes the turbine bearing housing.

Some of the air from the intermediate casing flows outwards through drillings into a heat shield surrounding the turbine bearing housing, and cools the outside of the bearing housing and the nozzle box inner cone before being ducted overboard through the cooling air outlet pipe. The remainder of the air passes through holes in the compressor and reduction gear drive shafts and along the turbine interstage air sleeve to cool the rear face of the low pressure disc; it is then discharged into the main gas stream.

The seven discharge nozzles which direct the gas flow into the turbine are cooled by air from the combustion chamber air casings.

This airflow enters the nozzle box through holes in the discharge nozzle inlets and, after passing over the nozzle guide vane outer platforms, joins the exhaust gas stream at the rear of the low pressure turbine shroud.

High pressure air is tapped from the second stage compressor and ducted into an annular space on the front face of the turbine high pressure disc (fig. 2). A labyrinth seal, secured by the turbine disc bolts, separates this air from the low pressure intermediate casing air. A second labyrinth seal permits a restricted flow of high pressure cooling air outwards across the front face of the disc; the remainder passes between the outer wall of the interstage sleeve and the central bores of the high pressure and intermediate pressure discs to cool the interstage disc faces. Labyrinth seals, positioned in the annular spaces between the three stages, control this flow of cooling air, allowing it to pass over the disc faces and join the main gasflow at the blade platforms.

The nozzle box is surrounded by a heat shield which is mounted on the exhaust attachment flanges and carries an integral fire extinguisher ring. A ring of holes through the rear support flange permits a cooling airflow to pass between the outside of the nozzle box and the shield.

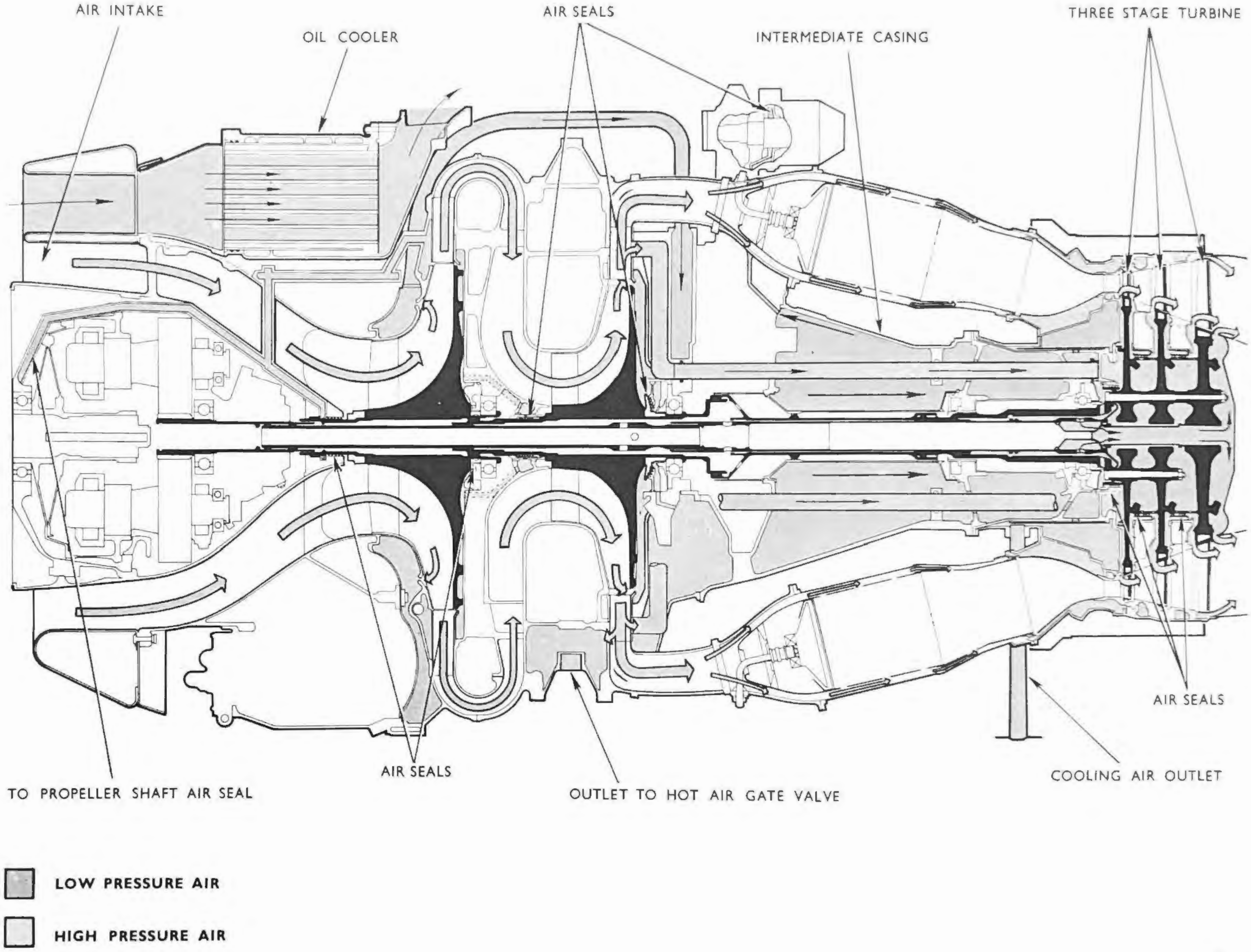


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Fig. 1 Cooling and sealing air system

SEALING AIR

A tapping from behind the first-stage diffuser provides air to pressurize the compressor front bearing and the propeller shaft labyrinth seal; the airflow to the former is fed into an annular groove between the oil and air labyrinth seals.

The front seal of the compressor interstage bearing is pressurized by air flowing from behind the rear face of the low pressure impeller. The interstage bearing rear seal is pressurized by air from the eye of the high pressure impeller; to prevent an excessive flow of this high pressure air into the bearing housing, a series of pressure balance holes connect the annular space between the thread and labyrinth sections of the rear seal with the airflow from behind the low pressure impeller. Air entering the bearing housing through the seals passes into the hollow compressor shaft and is discharged by the centrifugal breather.

The compressor rear bearing labyrinth seal is fed by air from the rear face of the high pressure impeller; air flowing across the labyrinth seal enters the centrifugal breather system.

High pressure air is bled through a drilling in the second-stage impeller casing into the large annular space in the compressor intermediate casing. This reduces the pressure difference and minimizes stresses in the casing. A tapping in the compressor intermediate casing delivers hot air to the gate valve for fuel filter de-icing.

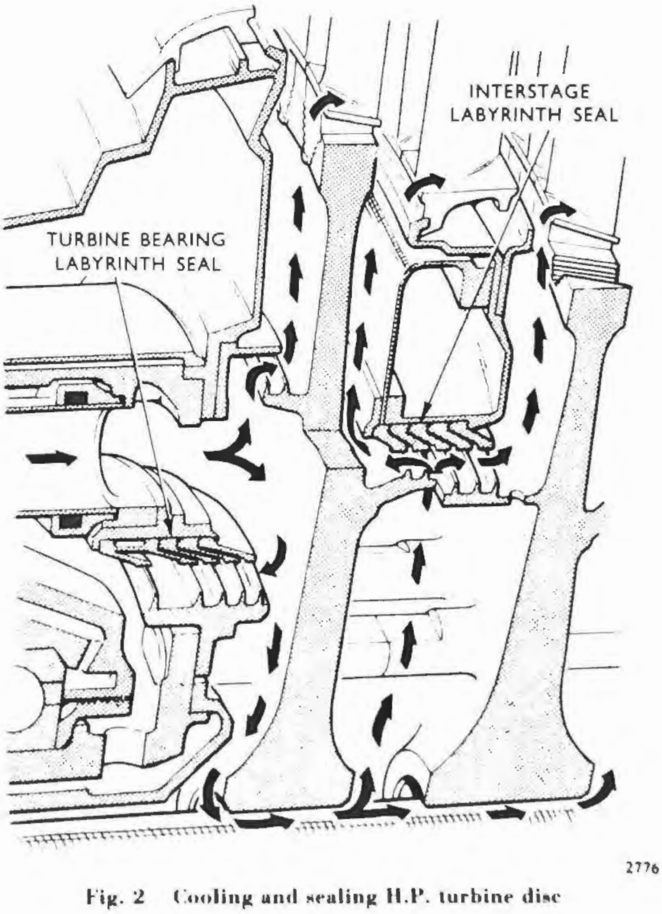


Fig. 2 Cooling and sealing H.P. turbine disc

CHAPTER 73 - ENGINE FUEL AND CONTROL

TABLE OF CONTENTS

73-0 Engine fuel and control

73-1 Fuel burners

73-2 Fuel pump

73-3 Fuel control unit

73-4 Fuel filter

DESCRIPTION

ENGINE FUEL AND CONTROL 1

The Dart fuel system, shown schematically in fig. 1, consists of atomizer burners fed by an interacting fuel pump and flow control unit; the latter embodies the throttle valve and a high pressure shut-off cock. Fine filtration of the fuel supply is provided by a felt filter in the feed line to the engine fuel pump.

When required, the fuel system is also protected by hot air from the second-stage compressor against the effects of ice formation from water which may be absorbed by the fuel under certain conditions.

The individual units of the fuel system are described in later sections in this chapter.

The output of the engine-driven fuel pump, a positive displacement plunger type unit, is matched to engine requirements by having its plunger stroke varied through the operation of a hydraulic servo system. The servo system is in turn controlled by the flow control unit to give automatically the required fuel flow according to the throttle valve opening and air intake pressure.

The flow control principle adopted is such that, at any given air intake pressure, fuel flow is determined by altering the effective area at the throttle valve opening while maintaining a constant pressure difference across it. This is achieved by manual operation of the profiled throttle plunger within the fixed orifice of the throttle valve, and by automatic operation of the servo system to maintain the required pressure difference.

It should be noted, however, that the opposite principle applies to the injection of fuel into the combustion chambers; the burner orifices are of fixed area, while the pressure in the fuel manifolds and burners varies and may rise to more than 1,150 p.s.i. at maximum flow conditions.

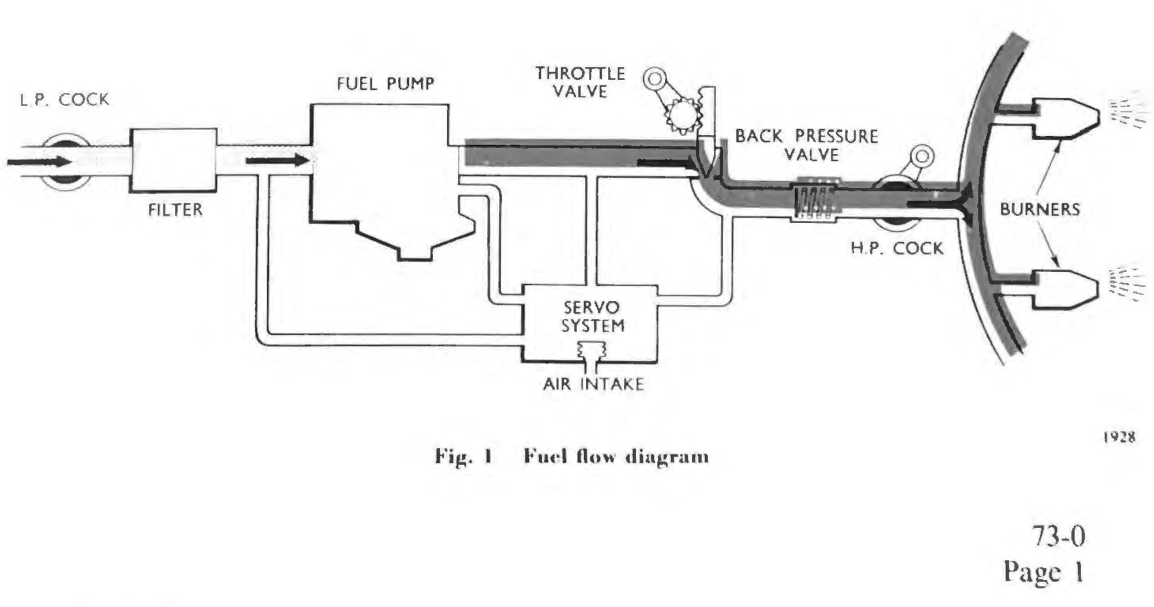


Fig. 1 Fuel flow diagram

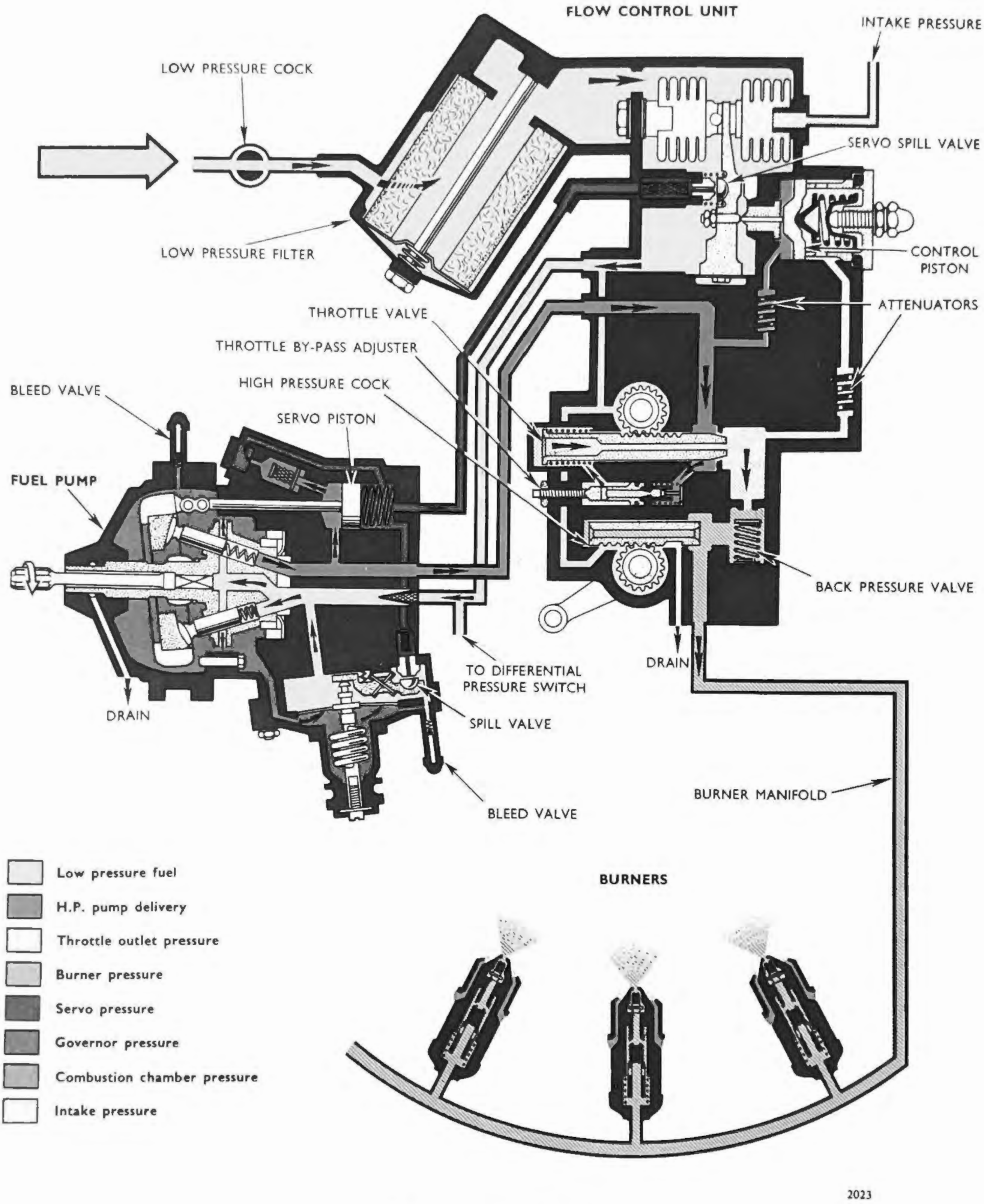


Fig. 2 Fuel system diagram

The function of the servo system is two-fold and ensures that:

At constant air intake pressure, the same pressure drop is maintained across the throttle valve whatever the position of the throttle plunger in the valve orifice.

At a given throttle setting, the pressure drop across the throttle valve and therefore fuel flow is varied in accordance with air intake pressure.

To establish a minimum back pressure for controlling purposes at low fuel flows and for starting, a back pressure valve is inserted in the fuel delivery line immediately after the throttle valve.

Normal operation of fuel system

The diagrammatic layout of the fuel system in fig. 2 shows that low pressure fuel from the aircraft system is admitted to the flow control unit through the felt filter and thence to the fuel pump inlet.

Rotated by the rotor against the inclined camplate, the fuel pump plungers deliver fuel at high pressure to the throttle valve, where it is controlled and passed through the back pressure valve and high pressure cock to the fuel manifold and burners.

Servo hydraulic pressure is produced by feeding the pump delivery pressure through a restrictor and allowing the restricted flow to return to the fuel pump inlet side through two controlled bleeds, one in the flow control unit and one in the fuel pump itself.

Flow through each bleed orifice, and hence servo pressure, is controlled by a spill valve; the valve in the flow control unit exercises normal control, while the one in the fuel pump acts as a safety valve against excessive fuel delivery pressure or overspeeding of the engine.

Under steady running conditions, the servo fuel pressure plus a spring on one side opposes fuel pump delivery pressure on the other to stabilize the servo piston at a given position. Increased bleed from the servo side reduces servo pressure, so causing the pump to reduce stroke to maintain the predetermined pressure difference across the throttle valve. Equally, reduced bleed from the servo side through closing off the spill valve will result in increased pump stroke and delivery to maintain the pressure difference as before.

Any alteration to air intake pressure, however, whether through change in forward speed or altitude, will affect the spill valve through a capsule assembly to maintain equilibrium at a different throttle pressure drop, i.e. there will be a change of fuel flow without a change of throttle plunger setting.

The compensation for changes in air intake pressure is such that fuel flow cannot be increased beyond the predetermined maximum permissible for static I.S.A. sea-level conditions.

Automatic limitation of maximum speed and pressure

The second servo spill valve, positioned in the fuel pump, serves to reduce servo pressure and pump delivery to prevent:

Excessive overspeeding of the engine should there be any failure of the normal propeller control.

Fuel pressure in the pump and delivery pipes from exceeding a safe limit, i.e. the 'stall' pressure.

Overspeeding is prevented by governor fuel pressure, produced by centrifugal action, overcoming a spring to open the spill valve and reduce pump stroke and delivery, whilst excessive pump delivery pressure causes a correspondingly high servo pressure which forces the spill valve off its seat.

B. Check the idling fuel flow

NOTE: The recommended method of checking the idling fuel flow is to check the burner pressure at idling r.p.m. and compare with the data plate burner pressure limitations.

(1) Disconnect, at the bulkhead, the manifold feed pipe to No.2 combustion chamber and insert a T-piece (1/8 in. B.S.P. threads) between the bulkhead connection and the flexible feed pipe.

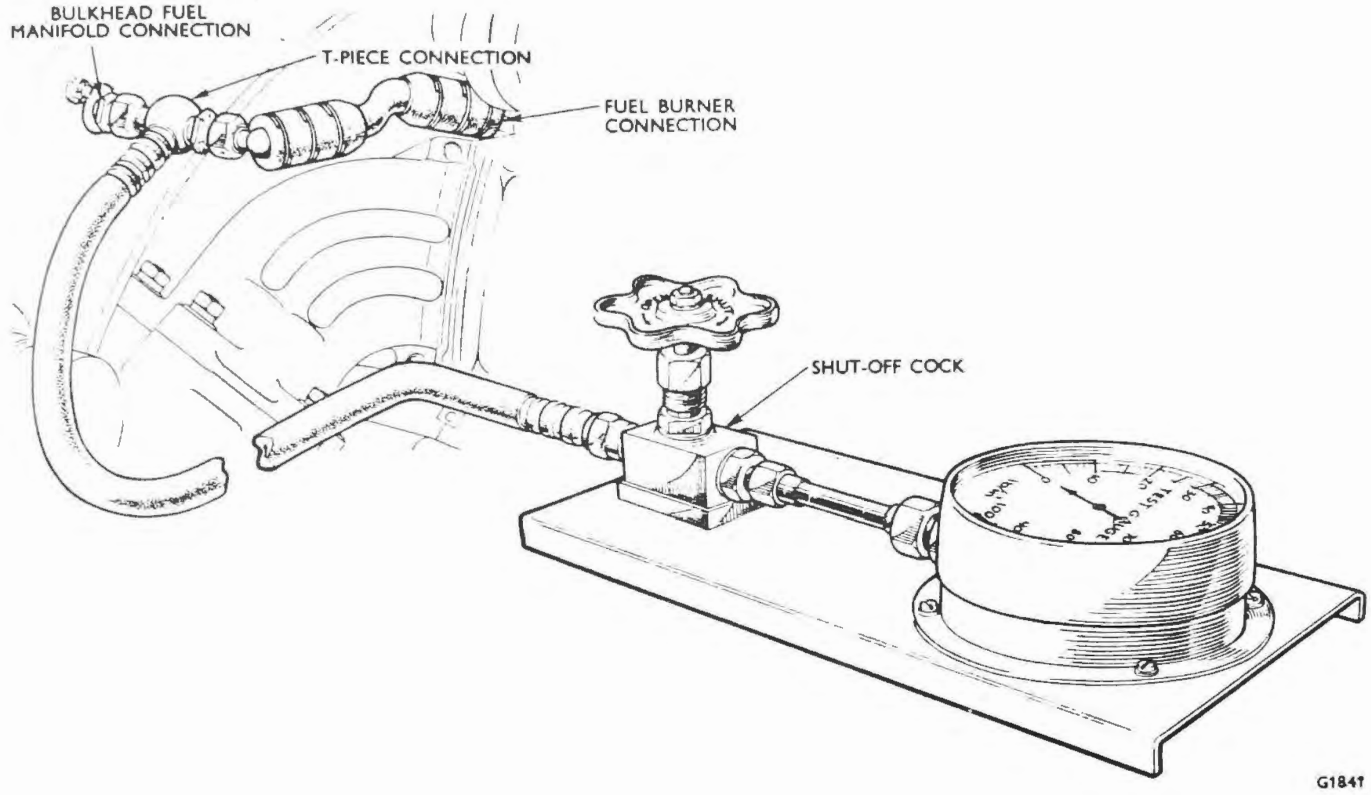
(2) Connect a Bourdon tube type pressure gauge, accurately calibrated between 0 to 100 p.s.i., to the T-piece (the gauge must be protected by a suitable pressure limiting valve if the engine is subsequently to be accelerated above idling conditions).

NOTE: A burner pressure test-set, Part No. J.83229 is available; in place of the limiting valve a shut-off cock is interposed. If the engine is to be run at conditions above idling r.p.m. the cock must be shut.

(3) Ensure that no air is trapped between the fuel manifold and the gauge capillary. When checking the gauge reading, allow for the pressure due to the head of capillary filling between the T-piece and gauge.

Corrections: Subtract 3 p.s.i. for 10 ft. head effect and pro rata.

Subtract 1.5 p.s.i. from the Data-plate burner pressure for every 1.000 ft. of pressure altitude above sea level.



Burner pressure test set
Fig.203

2. Adjustment/Test

A. Pressure test flexible pipes

Before being fitted to an engine, new and replacement pipes must be pressure tested using appropriate equipment and blanks. The table given below list the pipes, together with their individual test pressures.

Pipe	Test pressure p.s.i.
'WEATHERHEAD' or 'SILVOFLEX' hose	
Servo fuel pressure, fuel pump to F.C.U.	3,000
Fuel burner manifold	2,000
Fuel burner manifold to No.1 and No.2 burners	2,000
Fuel burner manifold to No.5 burner	2,000
Fuel supply to manifold and No.4 burner	2,000
'AVICA' or 'SUPER METALFLEX' hose	
Drain pipe, bulkhead to drain valve	50

FUEL BURNERS - MAINTENANCE PRACTICES

1. Servicing

A. General

(1) During service, accumulation of carbon may be removed from burner nozzles to rectify starting or handling defects during trouble shooting, Chap.71, 'POWER PLANT - TROUBLE SHOOTING'. This will ensure maximum life of the hot end components and trouble free starting.

B. Air washed burners

(1) On engines which are regularly started by using the aircraft batteries, clean the burners at 50 hour intervals.

(2) On engines which have a tendency to accumulate a heavy carbon deposit, clean the burners at 250 hour intervals.

(3) On engines with a normal rate of carbon accumulation clean the burners at 600 hour intervals.

NOTE: Air washed burners are cleaned by using wiping tool GU.18606 with brush head GU.18606 (Detail 4), or the scraper head GU.19610.

(4) Carry out the following checks before using the wiping tool and brush, or scraper head.

(a) Ensure that the bristles of the brush are in good condition and that the head is securely positioned on the tool as detailed below.

(b) If the scraper head is to be used, ensure that the rubber sleeve and blade are neither cracked, chipped or distorted.

(c) Ensure that the scraping edge of the blade is set parallel to the axis of the spindle part of the tool and that the head is securely positioned on the tool as detailed below.

(5) Referring to Fig.201 and using a vice, nut and rule, ensure that the distance between the tops of the bristles or the scraping edge of the blade and the axis of the spindle is 2.300 inches. This check is carried out by placing the zero mark on the rule in line with the tops of the bristles or the scraping edge of the blade, then turning the spindle through the 180 degrees. Divide the resultant reading by two. Ensure that with the spindle of the tool set at the fully out position (refer to Fig.201) the distance between face 'A' of the head and face 'B' of the tool locating member is 3.406 inches.

Fuel burners - Maintenance practices (cont.)

(6) If the head is not secure on the tool, or if it is necessary to reset the head or fit a replacement head, thoroughly clean the threads of the head and the tool. After applying sealing compound 'Loctite A' to the threads, set the head on the tool as previously detailed.

C. Cleaning the fuel burners (air washed)

CAUTION: DO NOT ATTEMPT TO CLEAN THE BURNERS ON A HOT ENGINE WITH THE BRUSH HEAD AS THE BRISTLES WILL BURN AND DISTORT.

(1) Remove the plug from the tool access boss (Mod.855 S.B.No.Da.72-39) or remove the suspension pin from the easiest accessible outer suspension pin boss (pre-Mod.855).

(2) Carefully insert the head of the tool through the boss of the air casing and the orifice of the flame tube, then screw the locating member of the tool fully into the boss.

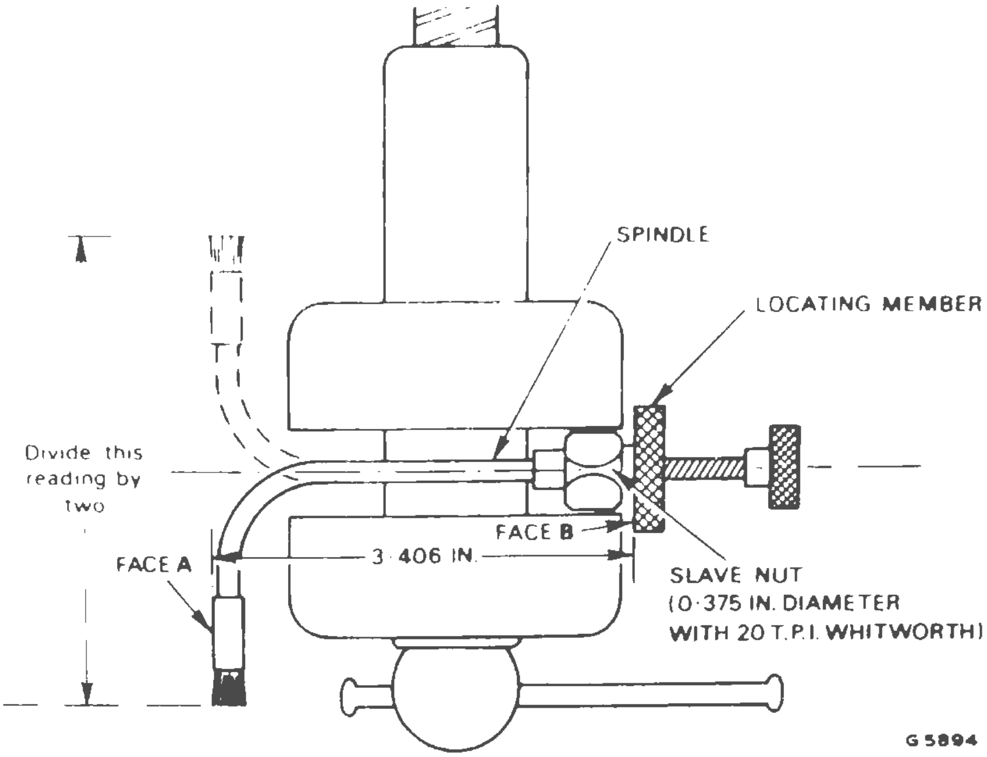
NOTES: 1. If the brush head is to be used, ensure that the bristles are not splayed by the boss threads or the orifice rim. If the scraper head is to be used, do not allow the rubber sleeve to contact the boss threads or the orifice rim.

2. When No.3 burner nozzle is to be cleaned, it is advisable to set the spindle of the tool at the fully out position in the locating member before inserting the head of the tool into the flame tube chamber. This method of insertion avoids the possibility of a foul between the tool and the high energy igniter.

(3) Slowly rotate the tool in the locating member by means of the knurled handle until the head is in contact with the burner nozzle, then rapidly move the head several times across the nozzle. Reposition the head on the nozzle by turning the tool one complete turn inwards and repeat the cleaning action. Repeat the inward movement of the tool progressively and the cleaning action until the whole area of the nozzle has been cleaned.

(4) Unscrew the locating member and withdraw the wiping tool from the combustion chamber then repeat (2) and (3) on the remaining burners.

(5) Lubricate the threads of the plugs (Mod.855) or pins (pre-Mod.855) with anti-seize compound; Chap.89-1, 'SERVICING AND STORAGE MATERIALS' then fit a plug, or a pin and new tabwasher to the threaded boss on each outer casing. Tighten the plugs or pins to the torque load specified in Chap.89-3 'TORQUE TIGHTENING TECHNIQUE'. Wirelock each plug with 0.028 in. stainless steel wire (89-1) or lock the pins with new tabwashers.



Burner wiping tool
Fig.201

D. Cleaning the fuel burners (fuel washed)

CAUTION: FUEL WASHED BURNERS MUST NOT BE BRUSH CLEANED BECAUSE OF THE RISK OF CARBON PARTICLES BLOCKING THE FUEL FLOW ANNULUS. IF EXCESSIVE CARBON FORMATION AROUND THE BURNER NOZZLE IS SUSPECTED, THE BURNERS SHOULD BE CLEANED, OR REPLACED BY A SERVICEABLE SET.

(1) The cleaning process consists of spraying the burner nozzles with a mixture of LIX 400 (or Turco 5884) and Butyl Cellusolve in equal proportions.

WARNINGS: 1. WHEN USING SOLUTIONS OF LIX 400 OR TURCO 5884, OPERATIVES MUST AVOID SMOKING AND WEAR PROTECTIVE CLOTHING WITH GOGGLES.

2. IF EITHER SOLUTION COMES INTO CONTACT WITH THE SKIN, WASH THE AFFECTED AREA IMMEDIATELY WITH SOAP AND WATER, THEN APPLY MEDICINAL PARAFFIN OR A LANOLIN BASED CREAM.

3. STORE THE SOLUTIONS AWAY FROM ANY HEAT SOURCE AND IN WELL VENTILATED CONDITIONS.

CAUTIONS: 1. BEFORE MIXING WITH BUTYL CELLUSOLVE THE LIX 400 OR TURCO 5884 MUST BE PASSED THROUGH A 50 MICRON FILTER.

2. AFTER SPRAYING THE BURNERS ENSURE THAT ALL TRACES OF THE CLEANING SOLUTION ARE CLEANED OFF IMMEDIATELY AND THAT NONE COMES IN CONTACT WITH RUBBER COMPONENTS AS THESE SOLUTIONS WILL DAMAGE THEM.

(2) Unlock and remove the blanking plug from the burner cleaning access boss in each combustion chamber air casing, the plug is located on the same radial plane as the flame tube suspension pins.

(3) Fill the fluid container of the burner spray tool GU.16264 with the solvent, then insert the curved nozzle of the spray tool into the hole and push home against the fluid container holder plate.

(4) Direct the nozzle forward by means of the holder plate then discharge the fluid with several strokes of the pump while twisting the nozzle from side to side to cover the fuel burner face and the front of the flame tube.

(5) Remove the spray tool nozzle from the combustion chamber, fit and lock the burner cleaning access plug and repeat the process on the remaining burners.

(6) Leave the engine to stand for at least 2 hours, but preferably 12 hours, to allow the solvent to soften the carbon deposits.

Fuel burners - Maintenance practices (cont.)

2. Removal/Installation

A. Remove the fuel burners

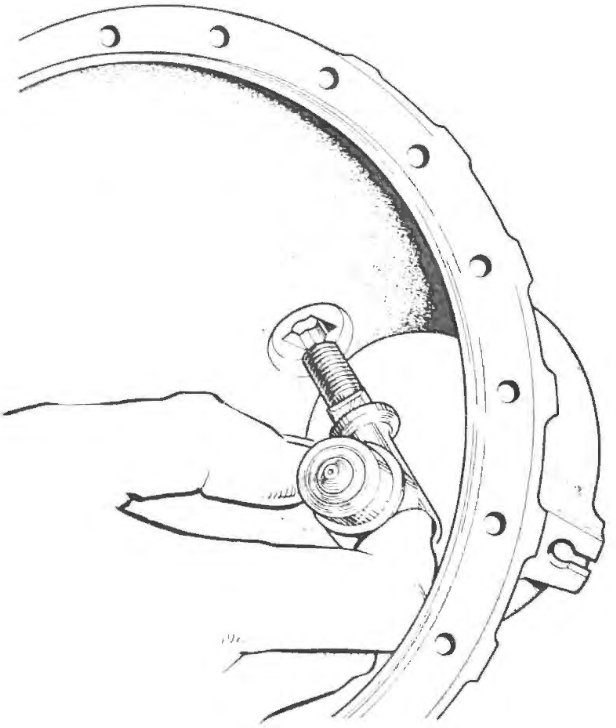
(1) Remove the combustion chamber from the engine (72-5).

(2) Remove the expansion chamber from the air casing (72-5).

(3) Remove the tabwasher and nut securing the burner to the expansion chamber and withdraw the burner.

CAUTION: DO NOT USE SELF-SHRINKING PROTECTIVE CAPS WHICH ARE STORED IN FLUID PRIOR TO USE BECAUSE OF THE RISK OF CONTAMINATION OF BURNER SURFACES.

(4) Fit a protective cap to the burner immediately it is removed.



Removing a fuel burner
Fig.202

B. Install the fuel burners

(1) Flush the replacement burner with engine fuel, and for engines subject to different modifications refer to the table and Fig.203 and check identification markings of the burner and expansion chamber burner flange immediately before installing the burner.

Fuel burners - Maintenance practices (cont.)

ENGINES SUBJECT TO MODIFICATIONS 1155 OR 1536		
Expansion Chamber No.	Burner Flange Identification	Burner Identification Flats
2 and 3	23 A.F.	Nil
E5 and G7	57 B.E.G.	1
1, 4 and 6	146	2

Example: A burner which has 2 flats on the thread of the fuel inlet connection and the number 146 stamped on the flange may be fitted to number 1, 4 or 6 expansion chamber.

NOTE: Mod.1155 refers to non-fuel washed burners with biased flow.
Mod.**1536** refers to fuel-washed burners with biased flow.

The joint use of fuel-washed burners and non-fuel washed burners on a particular engine must be avoided. When selecting burners it is of equal importance that the identification numbers are correct, and the type of burner corresponds to the engine specification.

(2) Using alignment fixture Part No. HW.23278, insert the burner into the expansion chamber with the burner head pointing to the rear, and locate the square section of the burner stem with the square in the expansion chamber. Should this fixture not be available, the $^{3}/_{8}$in. burner nut should not be tightened until the expansion chamber is refitted to the air casing, with the burner nozzle located in its orifice in the flame tube.

(3) Fit the plain washer, bevel face uppermost, over the threaded end of the burner protruding from the expansion chamber.

(4) Fit the tabwasher and securing nut; tighten the nut to the torque loading given in 89-3, then lock the nut.

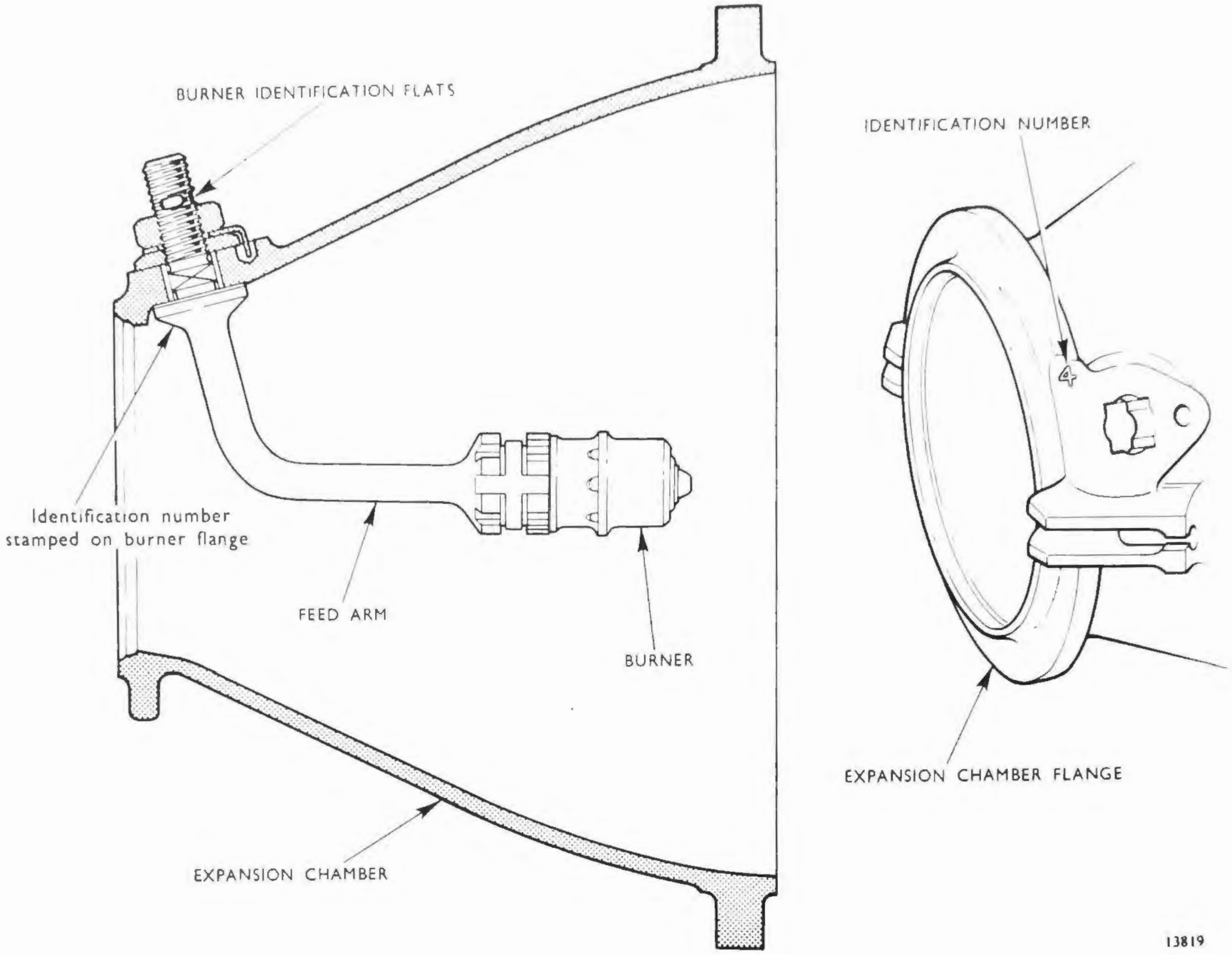
(5) Apply a thin film of the jointing compound specified in 89-1 to the mating faces of the expansion chamber and air casing.

(6) Fit the expansion chamber and burner assembly to the air casing and flame tube, entering the burner head into the centre of the flame tube swirl vane assembly. Check that the alignment marks on the expansion chamber and air casing coincide.

(7) Before securing the assembly ensure that the burner is correctly located in the central orifice of the swirl vane assembly, and a minimum clearance of 0.080in. is obtained between the fuel burner stem and the flame tube nose.

(8) Secure the assembly with the bolts, 'D' shaped washers, spring washers and nuts. The bolts fit with their heads to the rear i.e. with the flat on head abutting the bolt trap on the air casing.

Fuel burners - Maintenance practices (cont.)



Fuel burner and expansion chamber identification
Fig.203

3. Adjustment/Test

Carry out the recommended serviceability ground check (Engine/Power Plant, Adjustment/Test). After stopping the engine, inspect the combustion chambers for fuel leaks, gas blows and discolouration of the air casings. Check the fuel manifold for security, leaks, chafing, kinking and loose connections.

For pressures exceeding 75 p.s.i. the pipes are to be tested hydraulically, using kerosine or soluble oil in water. For pressures of 75 p.s.i. or less, clean, dry air is used with the pipe immersed in hot water at a minimum temperature of 60 degrees C. (140 degrees F.).

(1) Ensure that the bore of the pipe is clean and unobstructed before fitting it to the test equipment.

(2) Fit a blank and a pressure connection to the pipe and connect it to the test equipment.

(3) Raise the pressure gradually to the test figure but, on high pressure pipes, an intermediate check is to be made at 500 p.s.i. The pressure is to be maintained for a minimum of 2 minutes whilst a check is made for leaks, particular attention being given to the pipe end fittings.

(4) At the test pressure, which must be maintained for a minimum of 2 minutes, flex the pipe several times by hand through an angle of approximately 30 degrees.

(5) Reject any pipe which leaks.

(6) Release the pressure and disconnect the pipe from the test equipment.

(7) Degrease and dry the pipe.

3. Inspection/Check

A. Inspect rigid pipes

(1) Inspect all pipe fittings for corrosion, security and signs of leakage.

(2) Check all pipe clips, bonding leads and bonding lugs for security.

(3) Check all pipe connections for leakage.

NOTE: Leakage can be caused by mal-alignment or faulty sealing rings. Do not attempt to rectify mal-alignment until the pipe connections, keep plates and clips have been slackened.

B. Inspect flexible pipes

(1) Inspect all pipe fittings for corrosion, security and signs of leakage.

(2) Check that the pipes are not cut or chafed where they pass through clips or close to any adjacent component.

(3) Inspect the pipes for signs of cracking or kinking.

NOTE: Abnormal conditions causing accelerated ageing may result in surface crazing consisting of numerous minute cracks. These, by themselves, do not make a pipe unserviceable, but a careful check should be made at regular intervals so that any development of the crack can be detected and the pipe replaced.

(4) Any pipe removed from an engine is to be cleaned and its serviceability assessed from the following inspection:

(a) Inspect the end fittings for corrosion. Inspect the union nuts, threads and lockwire holes for damage. Inspect the seating faces of the spherical or banjo connections for distortion, damage and any nipple spread; any scoring, damage or excessive nipple spread which may cause leakage, will entail rejection of the pipe.

(b) Pipes which have taken up a permanent set through incorrect assembly are unacceptable; spiralling of the identification markings is an indication that this has occurred.

(c) Pipes that show deterioration through being exposed to excessive heat conditions i.e. burning or blistering should be rejected. Surface crazing or cracks caused by high temperature conditions is acceptable provided the cotton braiding is not exposed.

(d) Softening or swelling of the pipe outer cover caused by oil contamination is acceptable provided the outer cover is not in a semi-plastic condition i.e., sticky to the touch, or the outer cover is not detached from the inner metallic braid. The latter would be indicated by a blistering effect.

(e) Reject any pipe if the ident tags and pipe locating clips are bedded to the extent where they are below the surface area of the outer cover.

NOTE: When assessing the severity of cuts or cracks in the outer cover, particular attention should be given to cuts or cracks occurring on bends in the installed position of the pipes, as damage of this nature in an area under bending stress can cause further deterioration of the pipe and expose the wire braid.

(g) Check the pipe for obstruction of the bore. On some pipes a visual examination can be made, but where angle fittings are used, or if the pipe is too long for visual examination of the bore, kerosine must be pumped through the pipe to ensure that a free flow is maintained. The kerosine should be adequately filtered before it is pumped through the pipe.

(h) Pressure test the pipe (see 2. Adjustment/Test).

(5) When slackening or tightening union nuts on Mod.1587 (S.B.Da73-59) 'Aeroquip' fuel manifold pipes, secure the pipe nipple, using a spanner on the nipple hexagon, to prevent it from turning; it is possible to disturb the nipple, which is threaded into the sleeve, and cause fuel leakage.

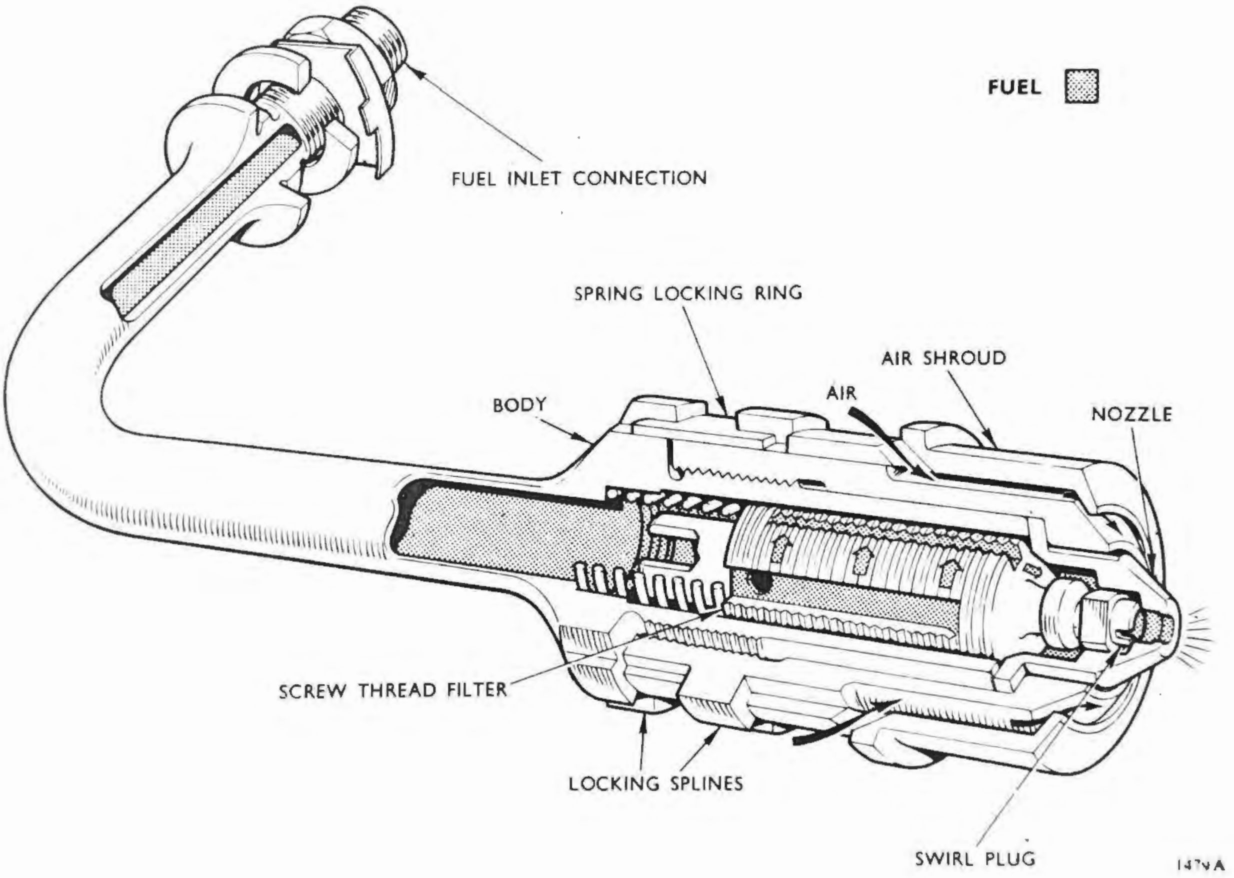
FUEL BURNERS - DESCRIPTION AND OPERATION

1. General

A. A fuel burner comprising a feed arm and burner head is fitted to each of the seven expansion chambers, and is located in the centre of the flame tube assembly. The feed arm is provided with a square section which locates in the expansion chamber wall to prevent twisting when the securing nut is tightened.

B. To prevent carbon formation at the nozzle orifice, burners are designed with a shroud around the burner head which directs a radial flow or air across the burner face.

C. To compensate for the variation in air flow to individual combustion chambers engines to Mod.1155 standard (S.B.No.Da73-21, air washed burners) or alternatively, Mod.1536 standard (S.B.No.Da73-56, fuel washed burners) incorporate burners with biased flow. Each burner is calibrated and numbered to give the required fuel flow to suit specific combustion chamber characteristics.



Burner
Fig.1

2. Operation

A. Fuel is injected into the combustion chamber through a single fixed orifice located at the apex of the conical swirl chamber in the burner head. Two slots direct the fuel tangentially into the swirl chamber, where it acquires a whirl velocity which increases progressively as the diameter of the swirl chamber decreases; the high velocity attained at the orifice ensures that the fuel discharged is directed downstream as a closely atomized conical spray.

NOTE: DELETED.

Fig.2 DELETED.

FUEL BURNERS - MAINTENANCE PRACTICES

1. Servicing

A. General

During service, accumulation of carbon may be removed from the air washed burner nozzles to rectify starting or handling defects during trouble shooting; carbon removal should be carried out at regular periods of 600 hours throughout the engine life and this regular burner cleaning will also result in an increase of hot end component life. If accumulation of carbon on the burners tends to be heavy, however, they should be cleaned at 250 hour periods.

CAUTION: FUEL WASHED (MOD.1536 - SERVICE BULLETIN No.Da73-56) BURNERS MUST NOT BE CLEANED BECAUSE OF THE RISK OF CARBON PARTICLES BLOCKING THE FUEL WASH FLOW ANNULUS. SHOULD EXCESSIVE CARBON FORMATION AROUND THE BURNER NOZZLE BE SUSPECTED DURING TROUBLE SHOOTING THE BURNERS SHOULD BE REMOVED AND, IF NECESSARY, RENEWED.

Air washed fuel burners should be cleaned using the steel bladed cleaning tool part number AK.894 or the nylon brush tools part number GU.17431/1 and GU.18606. If tool AK.894 is being used, examine it for cracks in the outer rubber moulding and fracture of the Bowden cable which, if evident, will necessitate rejection of the tool. If either of the brush tools, (under the above part numbers) however, are being used it is only necessary to check the condition of the brush head and renew it if required.

NOTE: Burner cleaning tools, part number AK.894 and GU.17431/1 are no longer manufactured.

CAUTION: DO NOT USE NYLON BRUSH TOOLS ON A HOT ENGINE AS THE BRISTLES WILL BURN AWAY THUS REDUCING THE EFFECTIVE LENGTH OF THE TOOL.

When replacing the brush head on nylon brush tools, smear the associated threads on the tool with 'Loctite A' sealing compound, then screw on the brush head to set an effective length of 2.3 inches from the top of the bristles to the centre line of the long arm of the tool.

B. Clean the fuel burners

(1) On each combustion chamber cut the locking wire and remove the plug (Mod.855, Service Bulletin No.Da72-39 -outer casing with additional boss for burner cleaning tool access)from the tool access boss or unlock the tab washer and remove the suspension pin (pre-Mod.855) from the easiest accessible outer suspension pin boss. Insert the tool into the combustion chamber and screw the locating member fully home into the threaded boss.

(2) Use great care when inserting the head of a nylon brush tool through the burner cleaning orifice to ensure the bristles do not become splayed by fouling the orifice lip, or the internal threads, thus making it difficult to enter the tool.

(3) If tool part number AK.894 is used, rotate the knurled handle on the free member one complete traverse of the threaded portion in each direction. If tool part number GU.17431/1 or GU.18606 is used, however, rotate the knurled handle until the brush is contacting the burner nozzle, then rotate the handle a quarter turn in each direction several times; continue turning the handle one full traverse of the threaded portion in each direction, pausing at each full turn to repeat the 'scrubbing' operation. Repeat the cleaning operation on the other burners

(4) Lubricate the threads of the plugs or pins with anti-seize compound (89-1) fit a plug or a pin and new tabwasher to the threaded boss on each combustion chamber, then tighten the plugs or pins to the torque load specified in 89-3 and lock the plugs using 0.028 in. stainless steel locking wire (89-1) or bend up the tabwasher on the suspension pins.

2. Removal/Installation

A. Remove the fuel burner

(1) Remove the combustion chamber from the engine (72-5)

(2) Remove the expansion chamber from the air casing (72-5)

Continued on page 202B

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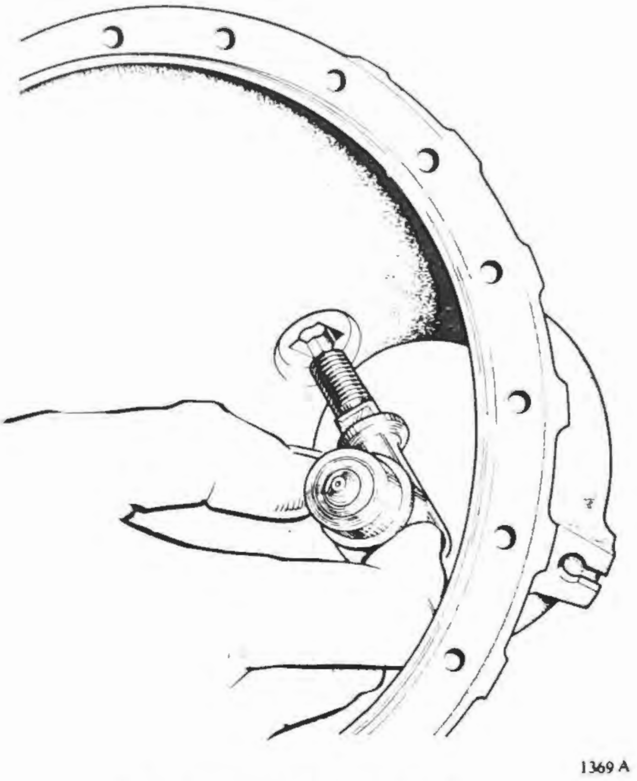
Fuel burners - Maintenance practices (cont.)

(3) Remove the tabwasher and nut securing the burner to the expansion chamber and withdraw the burner.

(4) Fit a protective sleeve to the burner immediately it is removed.



Removing Fuel burner

Fig.201

B. Install the fuel burner

(1) Flush the replacement burner with engine fuel, and for engines subject to different modifications refer to the table and Fig.202 and check identification markings of the burner and expansion chamber burner flange immediately before installing the burner.

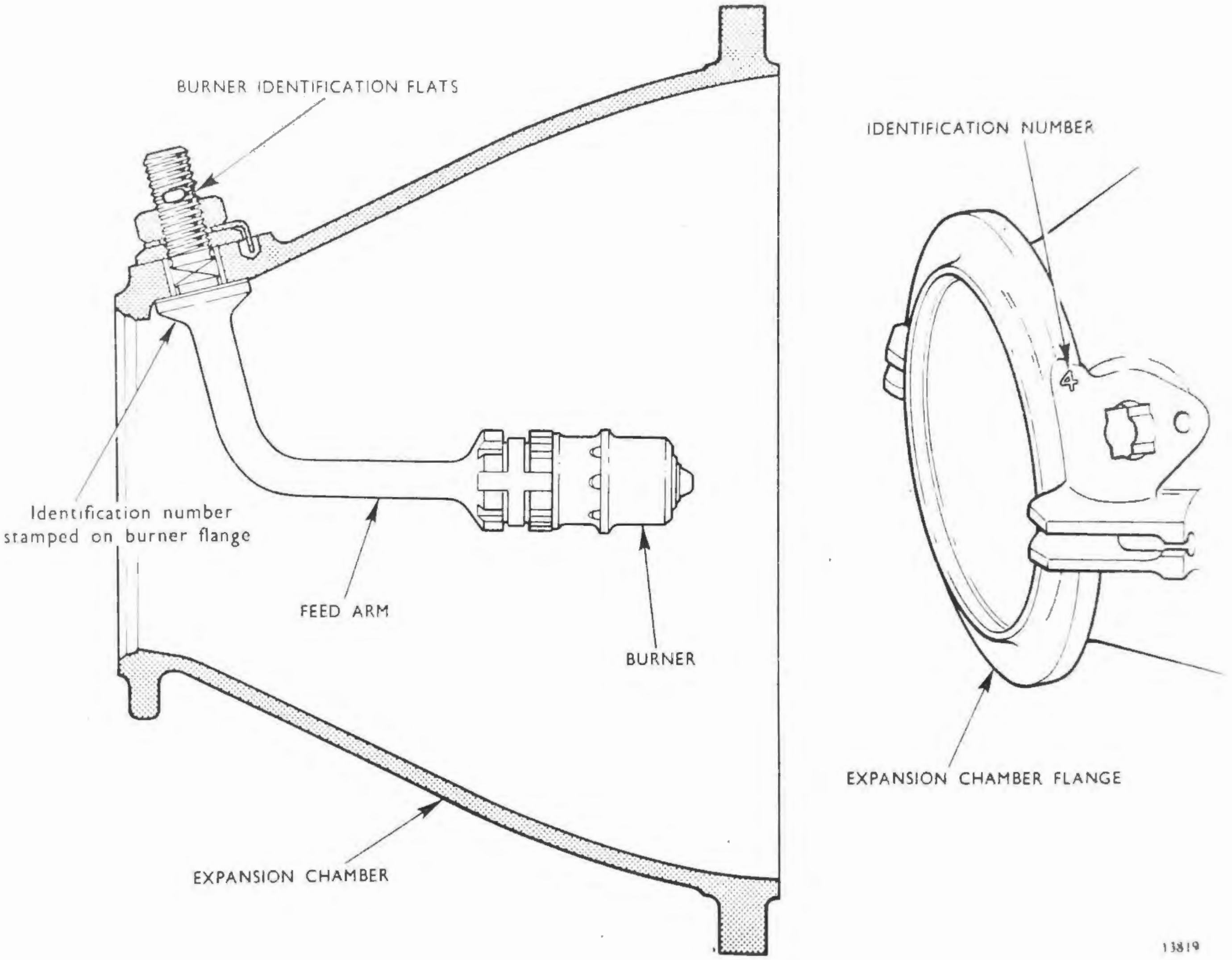
ENGINES SUBJECT TO MODIFICATIONS 1155 OR 1536		
Expansion Chamber No.	Burner Flange Identification	Burner Identification Flats
2 and 3	23 A.F.	Nil
E5 and G7	57 B.E.G.	1
1, 4 and 6	146	2

Example: A burner which has 2 flats on the thread of the fuel inlet connection and the number 146 stamped on the flange may be fitted to number 1, 4 or 6 expansion chamber.

Fuel burners - Maintenance Practices (cont.)

NOTE: Mod.1155 refers to non-fuel washed burners with biased flow. Mod.1536 refers to fuel-washed burners with biased flow.

The joint use of fuel-washed burners and non-fuel washed burners on a particular engine must be avoided. When selecting burners it is of equal importance that the identification numbers are correct, and the type of burner corresponds to the engine specification.



Fuel burner and expansion chamber identification
Fig.202

(2) Using alignment fixture Part No. HW.23278, insert the burner into the expansion chamber with the burner head pointing to the rear, and locate the square section of the burner stem with the square in the expansion chamber. Should this fixture not be available, the $^3/_8$in. burner nut should not be tightened until the expansion chamber is refitted to the air casing, with the burner nozzle located in its orifice in the flame tube.

(3) Fit the plain washer, bevel face uppermost, over the threaded end of the burner protruding from the expansion chamber.

(4) Fit the tabwasher and securing nut; tighten the nut to the torque loading given in 89-3, then lock the nut.

(5) Apply a thin film of the jointing compound specified in 89-1 to the mating faces of the expansion chamber and air casing.

(6) Fit the expansion chamber and burner assembly to the air casing and flame tube, entering the burner head into the centre of the flame tube swirl vane assembly. Check that the alignment marks on the expansion chamber and air casing coincide.

(7) Before securing the assembly ensure that the burner is correctly located in the central orifice of the swirl vane assembly, and a minimum clearance of 0.080in. is obtained between the fuel burner stem and the flame tube nose.

(8) Secure the assembly with the bolts, 'D' shaped washers, spring washers and nuts. The bolts fit with their heads to the rear i.e. with the flat on head abutting the bolt trap on the air casing.

3. Adjustment/Test

Carry out the recommended serviceability ground check (Engine/Power Plant, Adjustment/Test). After stopping the engine, inspect the combustion chambers for fuel leaks, gas blows and discolouration of the air casings. Check the fuel manifold for security, leaks, chafing, kinking and loose connections.

DESCRIPTION

FUEL PUMP

The function of the fuel pump is to deliver the fuel requirements of the engine at high pressure to the throttle valve in the flow control unit, where it is controlled before passing to the burners. The pump is fitted on the port side of the engine, and is driven by the lower bevel gears at approximately one-fifth engine speed.

The pump, illustrated in fig. 1 and 2, is an oscillating multi-plunger unit of variable stroke; it has a positive displacement at maximum stroke of about 10 gallons per hour per 100 r.p.m. of pump speed, with an output pressure which may exceed 1,200 p.s.i. All moving parts are fuel lubricated.

The connections to the pump are: inlet from the low pressure fuel filter in the F.C.U., outlet to the F.C.U., servo pressure connection to the F.C.U., and the drain; the latter is carried rearward to join the main engine drains, as described in Chapter 71.

The main parts of the pump are the rotor, the camplate, the servo mechanism, and a spill valve limiting servo pressure.

The rotor, which carries seven hollow rotor plungers, is driven by a shaft which is fitted with a seal to protect against oil inlet from the bevel box drive and against fuel leakage into the oil system. A drain common to both seals is incorporated, as shown in fig. 2.

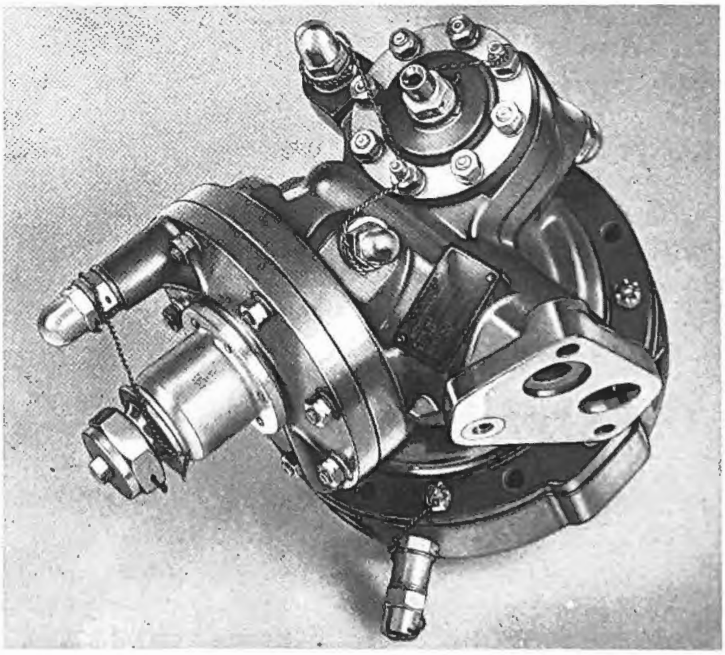


Fig. 1 Fuel pump

The pump operates on the swash principle, the stationary inclined face of the cam plate being presented to the plungers as they are revolved with the rotor. Movement of a servo piston alters the cam plate angle and therefore the length of plunger stroke; the effective delivery of the pump at a given r.p.m. therefore depends on the position of the servo piston.

The forces acting on the servo piston, which is lightly spring loaded towards the maximum stroke position, are pump delivery pressure on one side and servo fuel pressure plus the spring on the other. Servo fuel pressure is produced by fuel at pump delivery pressure entering a filter-protected metering orifice in the fuel pump and discharging normally through a half-ball spill valve in the flow control unit; the more the spill valve closes off, the nearer will servo pressure approach pump delivery pressure (see 73-0 and 73-3).

The fuel pump spill valve is of similar pattern (fig. 3). Normally held in the closed position by a spring, this valve opens to reduce servo pressure, pump

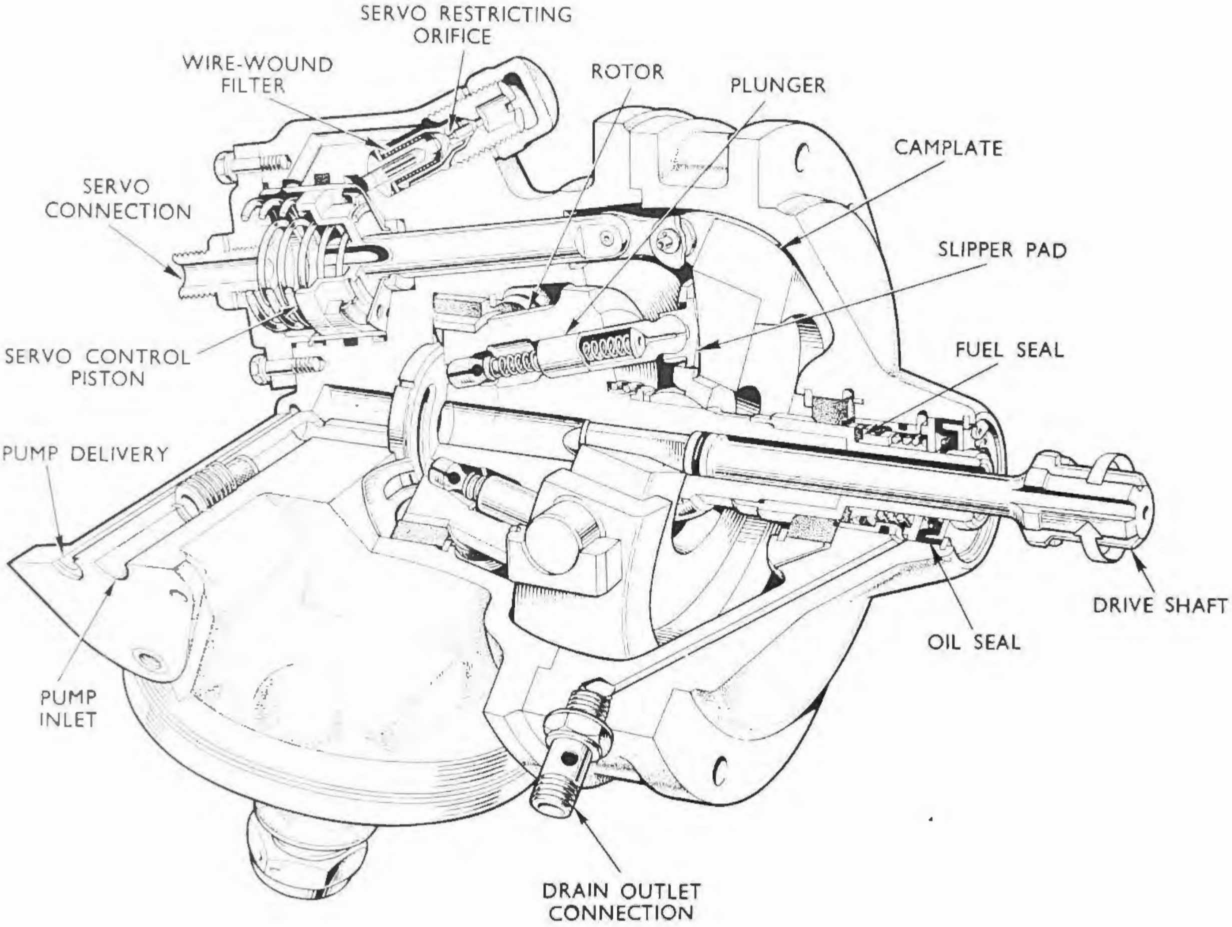


Fig. 2 Sectioned fuel pump

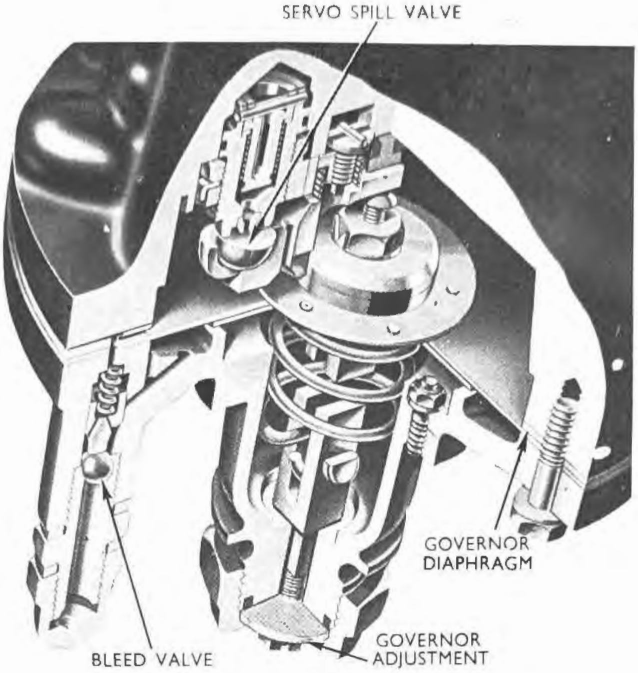


Fig. 3 Details of governor and bleed valve 1954

stroke and hence fuel delivery if the engine should overspeed through any failure of the normal propeller control or if the pump delivery pressure should rise excessively.

Overspeeding is prevented by radial drillings in the pump rotor causing at excessive r.p.m. a build-up in centrifugal fuel pressure which acts on the governor diaphragm to open the spill valve. Opposing this governor fuel pressure is inlet fuel pressure and a tension spring; the latter can be adjusted by a screw which is then locked by a capnut against a rubber sealing washer to prevent fuel leakage, as shown in fig. 3. Adjustment of the governor setting is described in 73-2 under 'Maintenance Practices.'

If for any reason the pump delivery pressure rises to the predetermined safe working limit for the fuel pipes and manifolds, servo pressure will increase proportionately and force the spill valve off its seat as a normal relief valve and so prevent any further rise. In this way, delivery pressure is prevented from exceeding what is termed the 'stall' pressure setting. Provision is made for attaching a gauge to measure pump delivery pressure.

Air in the fuel feed to the pump — which can be caused by running a tank dry or disconnecting at any point in the aircraft fuel supply system — will cause erratic running and the system must then be bled. Two spring-loaded ball valves are provided for this purpose on the fuel pump; one in the governor chamber itself, bleeding from both sides of the diaphragm when the valve is open only, and a second on top of the rotor chamber.

Each bleed point is blanked by a capnut; the type of valve is shown in fig. 3. Application of the special bleed tool, as described in 73-0 under 'Maintenance Practices,' depresses the ball and permits air and fuel to discharge.

FUEL PUMP - MAINTENANCE PRACTICES

1. Servicing

A. Fuel starvation

Interruption of the fuel supply to the pump for any reason, e.g. shortage of fuel or inadvertently closing the L.P. cock may result in erratic running due to air in the system, and since the pump is fuel lubricated, an excessive period of such dry running can result in damage to the pump.

Dry running will occur under the following conditions:

(1) Engine windmilling with H.P. cock open and L.P. cock closed.

(2) Engine windmilling after failure of L.P. fuel supply to the pump, e.g. fuel tank empty.

B. Dry running limitation

(1) Change the pump if dry running has occurred for more than 1 hour.

(2) If dry running has occurred for less than 1 hour rectify the cause of fuel shortage and bleed the fuel system, 73-0 Maintenance Practices.

NOTE: Dry running will not occur if both the H.P. and L.P. cocks are closed, provided that there was no failure of the L.P. fuel supply prior to closure of the cocks.

CAUTION: IF A PUMP IS REJECTED THROUGH A MECHANICAL FAILURE, THE FUEL CONTROL UNIT (F.C.U.) MUST ALSO BE REJECTED AND RETURNED WITH THE PUMP FOR SUSPECTED METALLIC CONTAMINATION.

C. Fuel pump cavitation

CAUTION: IF THE PRESSURE OF FUEL AT THE ENGINE INLET IS SIGNIFICANTLY REDUCED DURING FLIGHT AT HIGH ALTITUDE, THERE IS A DANGER THAT CAVITATION WILL TAKE PLACE IN THE PUMP. CAVITATION IS CAUSED BY PARTIAL VAPOURIZATION OF THE FUEL, AND ITS EFFECT IS TO GENERATE VIOLENT SHOCK WAVES AND VIBRATION IN THE ENGINE FUEL SYSTEM. IN SEVERE CASES, THIS WILL BE INDICATED TO THE PILOT BY FLUCTUATIONS IN FUEL FLOW, TORQUE PRESSURE, T.G.T. AND POSSIBLY R.P.M. LOW FUEL PRESSURE OR HIGH DIFFERENTIAL PRESSURE (FUEL FILTER BLOCKED) WARNINGS MAY ALSO BE RECEIVED.

PROLONGED RUNNING UNDER THESE CONDITIONS WILL CAUSE MECHANICAL DAMAGE TO THE PUMP AND METALLIC CONTAMINATION OF THE F.C.U. THERE IS ALSO A POSSIBILITY THAT THE FUEL TRANSFER PIPES AND ELBOW CONNECTIONS WILL BE DAMAGED, WITH SUBSEQUENT RISK OF FUEL LEAKAGE.

Fuel pump - Maintenance Practices (cont.)

D. Suspected pump cavitation reported

If suspected cavitation in flight for more than 5 minutes is reported, carry out the following:

(1) Change the fuel pump.

(2) Examine the transfer pipes and rubber sealing rings, between the F.C.U. and the pump, and the F.C.U. transfer pipe connections. If damage is observed or suspected, change the transfer pipes and/or F.C.U. (73-3), as required. Refer to '5. Leakage from fuel transfer pipes - F.C.U. to fuel pump'.

2. Removal/Installation

A. Remove the fuel pump

(1) Close the L.P. cock and drain the fuel system through the L.P. filter drain valve.

(2) Disconnect:

(a) Servo and drain pipes from the pump

(b) L.P. fuel pump (to differential pressure switch) from the inlet/outlet elbow.

(c) Ram pressure pipe clip from the pump mounting, Mod.906.

(3) Remove the two split (cotter) pinned nuts and the setscrew securing the fuel inlet/outlet elbow connection to the pump.

(4) Remove the bonding lead at the elbow connection.

(5) Pull the elbow and transfer pipes towards the front of the engine to release the assembly from the F.C.U., then withdraw the pipes from the connection, using the serrated spannersK.10733 and K.10735 or RK.10817 and RK.10818 to break the seals.

(6) Remove the eight securing nuts and washers, do not disturb the split (cotter) pinned nuts, and remove the pump from the engine.

B. Install the fuel pump

(1) Renew the eight rubber sealing rings on the two transfer pipes and the two rings between the fuel inlet/outlet elbow connection and the pump.

(2) Fit a new pump (to air intake casing) joint washer.

(3) Fit the pump to the engine and turn the engine to engage the pump drive shaft, if required.

Fuel pump - Maintenance Practices (cont.)

(4) Fit the plain washers and pump securing locknuts.

(5) Fit:

- (a) Transfer pipes to the inlet/outlet elbow.
- (b) L.P. fuel pipe (to differential pressure switch) to the inlet/outlet elbow.
- (c) Servo and drain pipes to the pump.
- (d) Ram pressure pipe clip to the pump mounting.

(6) Insert the transfer pipes into the F.C.U. connection.

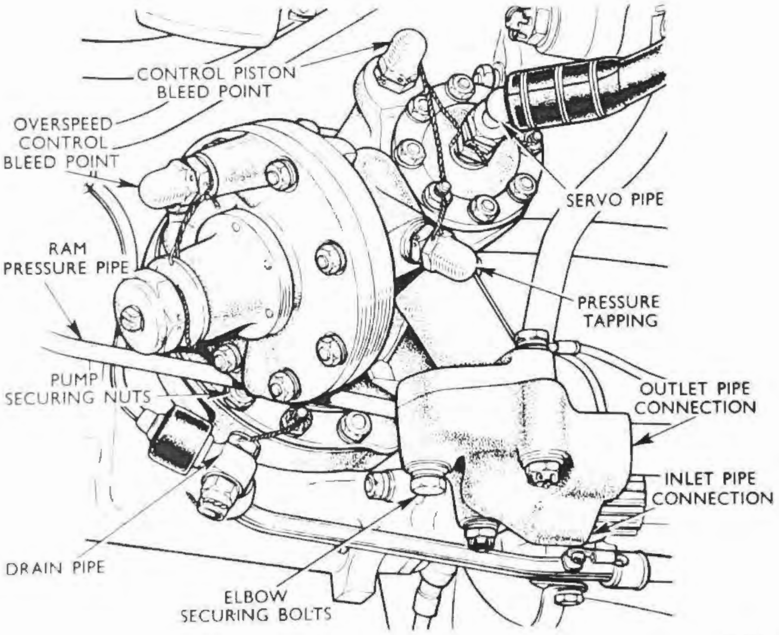
(7) Fit the bonding lead at the elbow connection.

(8) Secure the elbow to the pump with the setscrew and two nuts.

(9) Split (cotter) pin the nuts.

(10) Bleed the fuel system, see 73-0.

(11) Set the fuel pump governor, '3. Adjustment/Test'.



Fuel pump connection and bleed points
Fig.201

3. Adjustment/Test

A. Set the fuel pump governor

NOTE: Because of the maximum engine speed limitation, it is not permissible to overspeed the engine to the r.p.m. at which the governor normally controls. It is necessary, therefore, to check and set the governor with the engine running at a lower engine speed which corresponds to a predetermined amount of adjustment from the actual final governor setting.

(1) Disconnect the r.p.m. control rod from the cross-shaft lever and secure the r.p.m. lever on the propeller controller unit against the maximum r.p.m. stop.

(2) Move the H.P. cock to the fully forward (LOCK OUT) position and trip the automatic feathering circuit breakers, to prevent the propeller auto-feathering under the resulting low torque conditions.

(3) Fit the setting jig AK.969A or GU.21377 (Fig.202) to the H.P. fuel pump as follows:

(a) Clamp the graduated plate to the centre boss of the fuel pump governor chamber, with the clamp just clear of the adjusting screw capnut.

(b) Fit the pointer and socket to the adjusting screw so that the pointer coincides with the 180 degrees mark on the plate as shown in Fig.202.

CAUTION: IT IS ESSENTIAL THAT THE GOVERNOR ADJUSTING SCREW CAPNUT, REFERRED TO IN PARA. (4), (6) AND (10), IS TIGHTENED TO THE TORQUE LOADING SPECIFIED IN CHAP.89-3.

(4) Remove the locking wire and slacken the capnut on the governor adjusting screw, rotate the pointer anti-clockwise to the 0 degree mark and retighten the capnut to the torque load specified in Chap.89-3; ensure that the pointer is not displaced from the 0 degree mark on the graduated plate.

(5) Run the engine as instructed in Chap.71-0, open the throttle fully and check that engine speed is governed at 14,700 r.p.m. plus 0 or minus 100 r.p.m. Do not allow engine speed to exceed 15,000 r.p.m.

(6) If the governor setting is incorrect, slacken the capnut and turn the adjusting screw clockwise to increase the governed speed or vice-versa; turning the screw through 90 degrees alters the governed speed by approximately 800 r.p.m. After adjustment, retighten the capnut to the specified torque load, then recheck the governed speed as instructed in para.(5).

Fuel pump - Maintenance Practices (cont.)

(7) When a satisfactory governor setting is obtained (14,700 r.p.m. plus 0 or minus 100 r.p.m.), stop the engine.

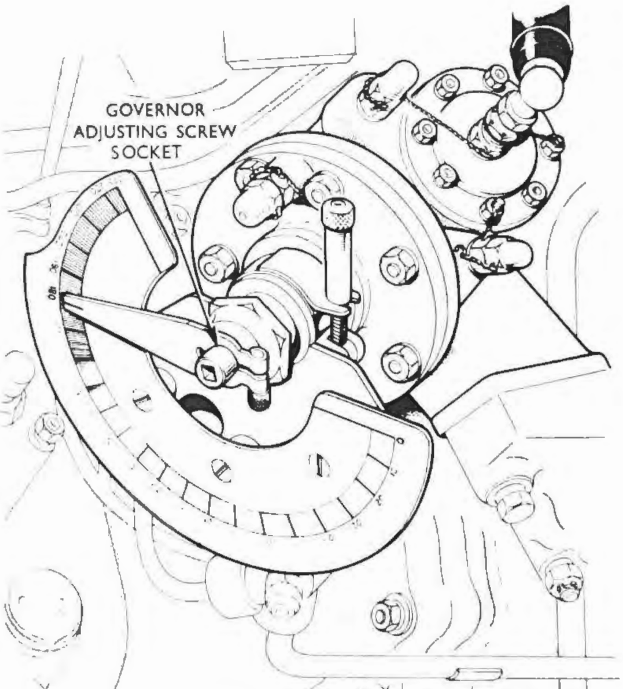
(8) If any adjustment was necessary, slacken the pointer clamping bolt, reposition the pointer so that it coincides with the 0 degree mark on the graduated plate and retighten the clamping bolt.

(9) Slacken the capnut and carefully turn the governor adjusting screw in a clockwise direction until the pointer coincides with the 180 degrees mark on the plate. This adjustment sets the governor to control at the actual governed speed, but do not attempt to check this setting.

(10) Tighten the capnut to the specified torque load, taking care not to displace the pointer and adjusting screw, remove the setting jig and lock the capnut with 0.028 in. stainless steel wire.

(11) Release the r.p.m. lever from the maximum r.p.m. stop and reconnect the r.p.m. control rod to the cross-shaft lever.

(12) Restore the electrical supply to the automatic feathering circuit.



Fuel pump governor setting jig
Fig.202

(13) Carry out the engine serviceability ground run (see 71-0, 'Adjustment/test').

4. Inspection/Check

A. Check the fuel pump delivery pressure

A check of the fuel pump delivery pressure may be necessary in the course of defect investigation, as described in 71-0, 'Trouble shooting'.

(1) Remove the domed nut from the pressure tapping on the fuel pump as shown in fig.201.

(2) Fit a pressure gauge calibrated to 300 p.s.i. to the pressure tapping.

(3) Carry out a motoring cycle (see 71-0, 'Adjustment/test') and note the pressure.

B. Visually examine the pump and pipe connections for security and signs of leakage.

5. Leakage from fuel transfer pipes - F.C.U. to fuel pump

NOTE: If a leak occurs in the region of the fuel transfer pipes between the F.C.U. and the fuel pump, remove the transfer pipes (refer to fuel pump removal) and make the following dimensional checks. Pipes worn beyond limits must be rejected.

A. Check that the diameters at the base of the sealing ring grooves and of the seal lands, are not less than the following dimensions.

	Sealing ring groove	Seal land
L.P. transfer pipe	0.810in.	0.984in.
H.P. transfer pipe, Part Number RK.15568 (Pre-Mod.1164)	0.558in.	0.734in.

Mod.1164 Introduces a new H.P. fuel transfer pipe strengthened by increasing the cross-sectional thickness. The diameter of the centre land at each end of the pipe is increased and new closer limit rubber rings are fitted in vee shaped sealing grooves.

B. Inspect the fuel pump and F.C.U. transfer pipe locating bores for frettage. Frettage is permissible provided the maximum depth does not exceed 0.003in. and does not extend around the circumference for more than 180 degrees.

C. Renew the sealing rings on the transfer pipes whenever the pipes have been disturbed.

Fuel pump - Maintenance Practices (cont.)

6. Preservation

Fill the unserviceable pump with the inhibiting fluid specified in 89-1. Ensure that the pump is completely full by turning the pump driving shaft, and then blank off all the openings.

DESCRIPTION

FLOW CONTROL UNIT

The flow control unit, illustrated in fig. 1 and 2, is mounted on the lower port side of the compressor intermediate casing. Its function is to control the delivery from the fuel pump to suit the airflow at any given engine r.p.m. and air intake pressure.

The unit, made up of three main castings, houses the throttle valve, servo control mechanism, high pressure shut-off cock and low pressure fuel filter; the latter is described in 73-4. The two main halves of the unit have a face-to-face joint, fuel transfer passages being sealed by rubber rings; the filter bowl has a rubber sealed joint.

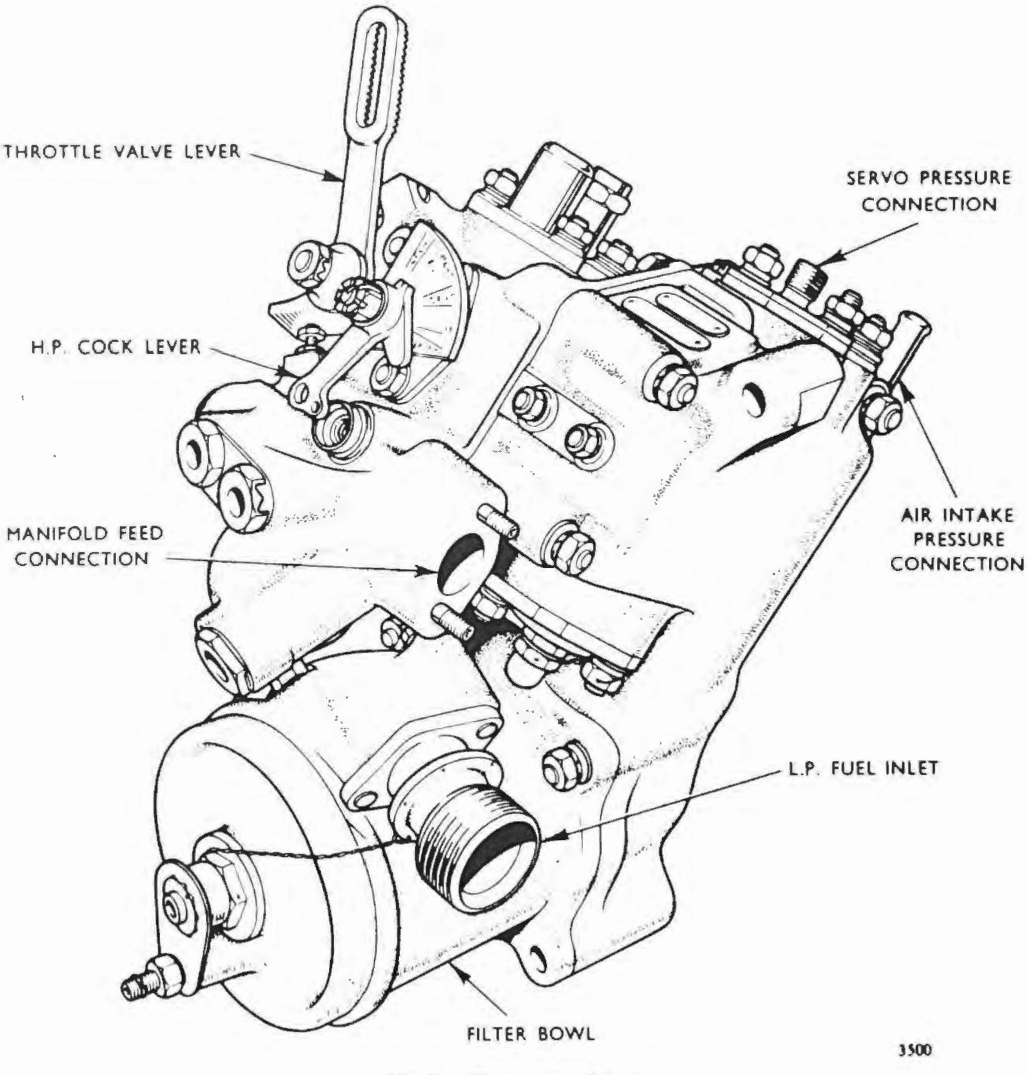


Fig.1 Flow control unit

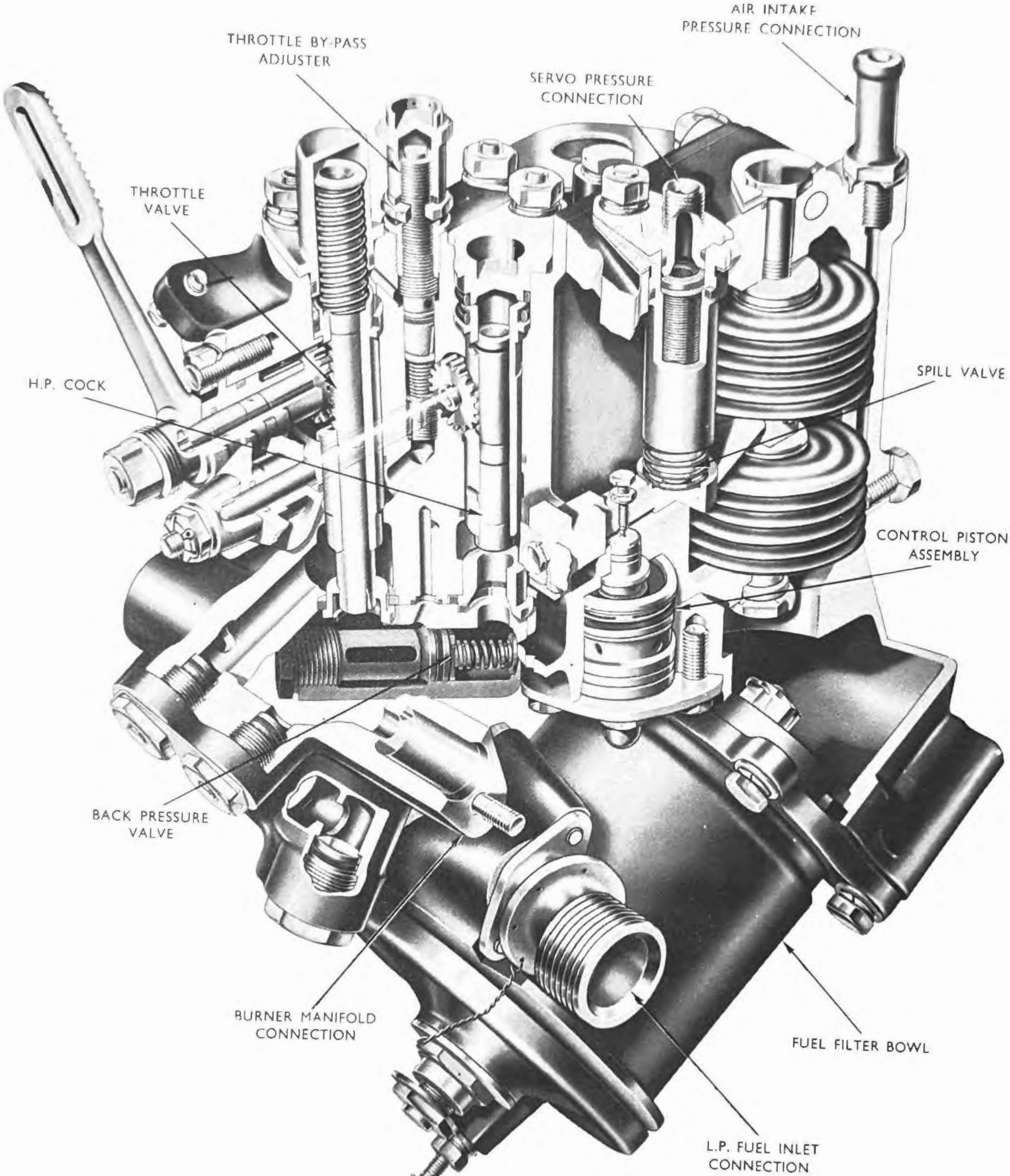

AIR INTAKE PRESSURE CONNECTION
THROTTLE BY-PASS ADJUSTER
SERVO PRESSURE CONNECTION
THROTTLE VALVE
SPILL VALVE
H.P. COCK
CONTROL PISTON ASSEMBLY
BACK PRESSURE VALVE
BURNER MANIFOLD CONNECTION
FUEL FILTER BOWL
L.P. FUEL INLET CONNECTION

Fig. 2 Sectioned flow control unit

2012

Connections to the flow control unit are: the aircraft low pressure fuel supply inlet at the fuel filter, the fuel feed and return pipes, together with the servo pipe, to the fuel pump, the pipe carrying a sample of air intake pressure to the unit. A fuel drain connection is also provided which joins the drain from the fuel pump and the water/methanol unit at the engine bulkhead prior to discharge rearward through the drain valve and thence overboard (see Chapter 71)

Throttle valve

The throttle valve consists of a hollow plunger, of uniform diameter but profiled by graduated slots, working in a fixed orifice. The plunger is operated through a rack and pinion by a throttle valve lever which, together with the r.p.m. selector lever on the propeller controller unit, is connected to the pilot's power (throttle) lever in the cockpit. The arrangement of engine controls is described in 76-0.

To minimize the force required to operate the throttle, the fuel pressures at each end of the plunger are balanced. The plunger is also spring loaded to take up any backlash between the rack and pinion; this assists accurate control of the fuel flow and matching of it to the airflow as determined by the engine r.p.m. selected.

Some fuel is permitted to by-pass the throttle valve. This throttle valve by-pass is adjustable for use on rig test only to enable the throttle valve to be calibrated.

The throttle pinion shaft, the throttle plunger sleeve, and the throttle orifice are each sealed into the casing with close-tolerance rubber seals.

High pressure cock

The H.P. cock is also a rack and pinion operated hollow plunger. In the closed position, the plunger cuts off the fuel supply to the burners and diverts it back to the pump inlet, so avoiding excessive pressure in the fuel pump delivery line. At the same time, two slots formed axially in the plunger permit fuel already in the fuel manifold and burner feed lines to drain or be blown out to atmosphere by the combustion chamber air pressure on run-down.

The H.P. cock is arranged to permit further movement beyond the shut position to enable it to be interconnected with the propeller manual feathering control, as described in 76-0.

As with the throttle, the H.P. cock pinion shaft, plunger sleeve and orifice are each sealed into the casing with close-tolerance rubber seals.

Servo control mechanism

The mechanism which controls fuel pump output through control of servo pressure (see 73-0) is contained in the flow control unit. As shown in fig. 3, it consists of a half-ball spill valve carried on a spring-hinged lever which is acted upon by a ***control piston assembly*** tending to close the valve, and a spring and a ***twin capsule assembly*** tending to open it.

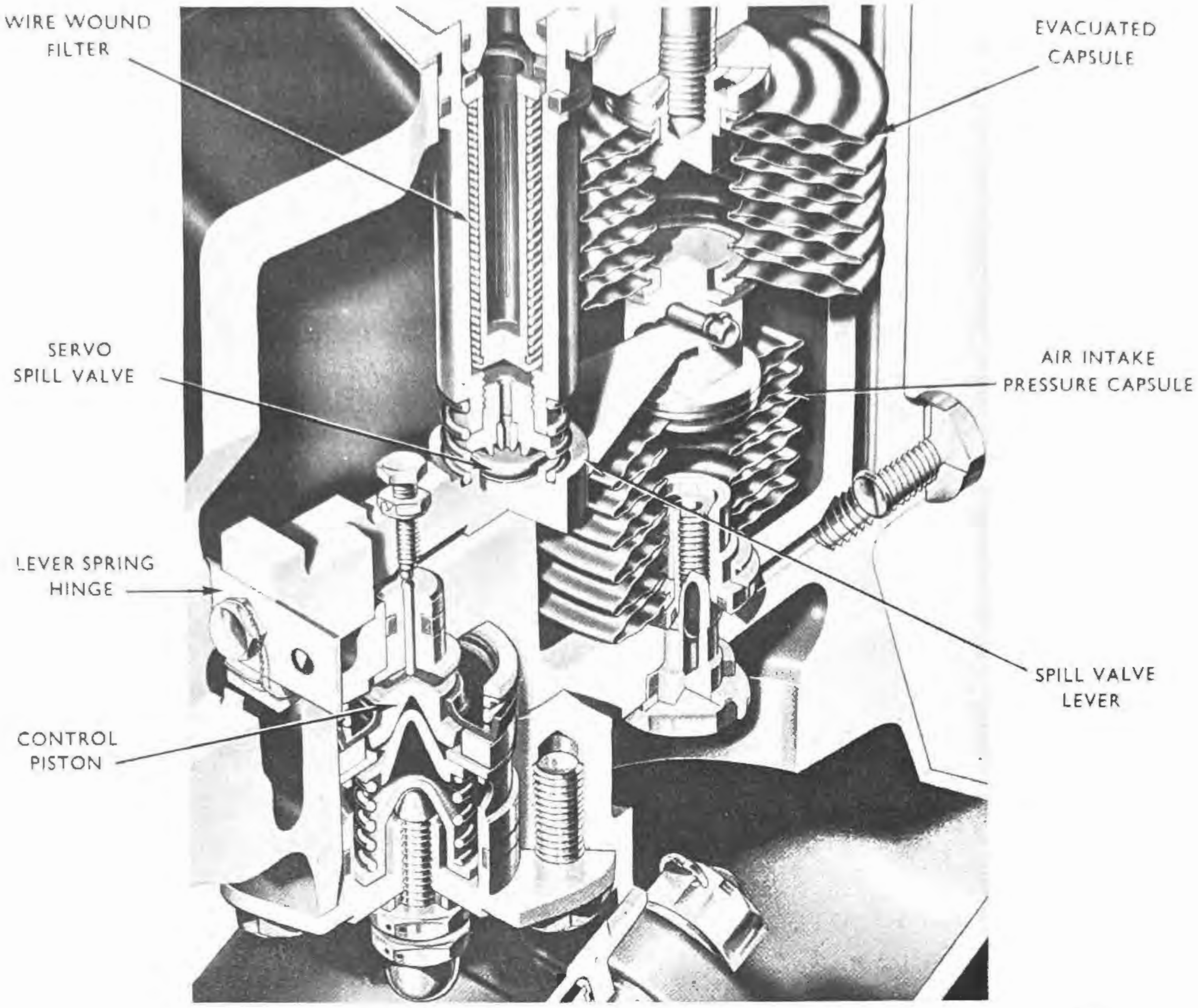


Fig. 3 Flow control unit servo spill valve

A ***back pressure valve*** is also fitted immediately after the throttle valve to provide sufficient pump delivery and servo pressure for controlling purposes at low fuel flows.

The piston in the ***control piston assembly*** is subject to the pressure difference existing across the throttle valve, sample pressures from upstream and downstream of the throttle being led through attenuators to the opposite sides of the piston; equilibrium is maintained by a spring on one side of the piston, this spring being adjusted during rig test only.

Should the pressure difference across the throttle fall below the required value, the control piston will move to close off the spill valve, so increasing the servo pressure and pump stroke; equally, if the pressure difference across the throttle and control piston becomes too great, the control piston will move to permit an increased opening of the spill valve to reduce servo pressure and pump stroke.

The controlling movement of this valve is very small, and its orifice is protected by a fine wire-wound filter to prevent possible interference by any small particles in the fuel.

The function of the ***twin capsule assembly*** is to correct the fuel flow for changes in altitude or aircraft speed. The assembly is immersed in low pressure fuel and consists of an evacuated capsule and another, of equal effective area, subject internally to air intake pressure.

The capsule assembly is arranged to increase progressively the loading tending to open the servo spill valve with increase in altitude, so causing the unit to stabilize at a progressively lower pressure drop across the throttle valve and hence lower fuel flow.

The linkage with the lever carrying the spill valve is such that it has no effect should the air intake pressure rise above I.S.A. static sea-level, e.g. through ram effect at low altitude; fuel flow cannot therefore rise above the maximum for take-off conditions.

FUEL CONTROL UNIT - MAINTENANCE PRACTICES

1. Removal/Installation (Fig.201)

A. Remove fuel control unit (F.C.U.).

CAUTION: (1) THE FUEL CONTROL UNIT MUST BE CHANGED IF THE H.P. FUEL PUMP IS REJECTED FOR MECHANICAL FAILURE. DO NOT GROUND RUN THE ENGINE PRIOR TO REMOVAL OF THE FUEL CONTROL UNIT.

(2) DURING REMOVAL OF THE FUEL CONTROL UNIT, FIT BLANKS TO ALL EXPOSED APERTURES AND PIPE ENDS, AND DISCARD ALL SEALING RINGS.

(1) Prior to a fuel control unit change in service, ground run the engine to establish a Datum T.G.T. value. Refer to Chap.71-0, Sub-section 4D 'REMOVAL/RE-INSTALLATION GROUND RUN - DRY' and carry out actions A,B,D (T.G.T. only), G and H of RUN 1, Pre-removal run. If the engine cannot be run prior to the fuel control unit change, refer to 2.Adjustment/test, para.B.

(2) Close the aircraft L.P. fuel valves.

(3) Position a clean container of suitable capacity under the L.P. fuel filter, then open the drain valve and drain the fuel system.

CAUTION: IF DRAINED FUEL IS CONTAMINATED, INVESTIGATE THE CAUSE AS INSTRUCTED IN CHAP.89-8.

(4) Disconnect the throttle and H.P. cock control rods from their associated levers on the fuel control unit.

(5) Remove the inlet/outlet elbow from the H.P. fuel pump and disconnect the inlet and outlet pipes from the fuel control unit; refer to Chap.73-2.

(6) Unlock and remove the hollow bolt securing the banjo union and disconnect the drain pipe from the fuel control unit.

(7) Disconnect the clip securing the drain pipe to the bulkhead and rotate the pipe clear of the fuel control unit.

(8) Unlock and disconnect the servo pipe from the threaded connection on the fuel control unit.

CAUTION: THE NUTS SECURING THE SERVO PIPE CONNECTION TO THE FUEL CONTROL UNIT MUST NOT BE LOOSENED OR REMOVED WHEN DISCONNECTING THE SERVO PIPE, OTHERWISE THE SERVO SPILL HALF-BALL VALVE WILL BE DISPLACED WITH CONSEQUENT MALFUNCTION OF THE FUEL CONTROL UNIT.

(9) Disconnect the ram pressure pipe from the fuel control unit as follows:

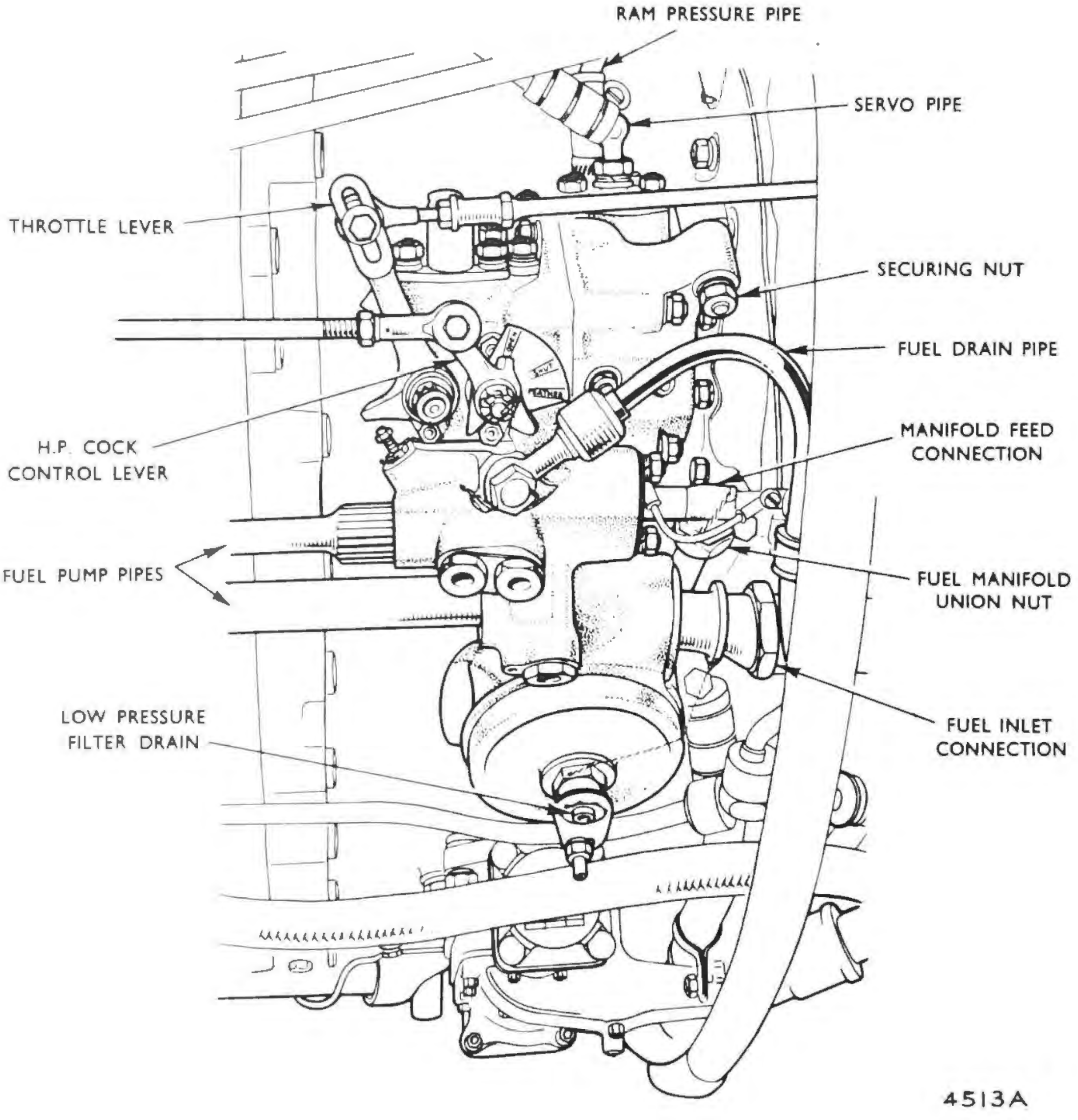
Fuel control unit - Maintenance practices (cont.)

(a) On engines to pre-Mod.906 standard, unscrew the hose clip securing the pipe to the connection on the upper face of the fuel control unit and disconnect the ram pressure pipe.

(b) On engines embodying Mod.906 (S.B.Da73-11), disconnect the two clips securing the ram pressure pipe to the H.P. fuel pump and the fuel control unit,remove the connection at the air intake casing and withdraw the pipe from the connection on the lower face of the fuel control unit.

(10) Unlock the union nut and disconnect the fuel manifold from the feed connection on the fuel control unit.

(11) Unlock the union nut and disconnect the burner manifold branch pipe from No.4 combustion chamber.



Fuel control unit
Fig.201

(12) Remove the bolts, spring and plain washers and nuts from No.5 branch pipe support housing on the fireproof bulkhead, withdraw the housing and remove the sleeve, split sealing plate and split Tufnol bushes, noting the order of removal to facilitate assembly.

(13) Remove the plain nuts, spring and plain washers securing the flange of the manifold feed connection to the fuel control unit: remove the bonding lead and withdraw the connection, then withdraw the manifold feed connection and flexible branch pipe forward through the bulkhead, collecting the support housing and backing plate.

(14) Unlock the sleeve nut and disconnect the L.P. fuel inlet pipe from the fuel control unit.

(15) If the aircraft installation features a fuel temperature indicating system, disconnect the electrical cable and remove the fuel temperature bulb from the L.P. filter bowl.

(16) Remove the plain nuts, spring washers and bevelled washers and withdraw the F.C.U. from the mounting studs on the engine. Where a Mod.1332 F.C.U. is fitted, remove the anti-frettage washer from the rear mounting stud and secure it to the F.C.U. using suitable locking wire.

(17) After removal, drain any residual fuel from the unit and fill it with the inhibiting oil specified in Chap.89-1, then fit blanks to all open connections.

B. Install fuel control unit

CAUTION: TO AVOID CONTAMINATION OF THE FUEL SYSTEM DURING INSTALLATION OF THE F.C.U. DO NOT REMOVE BLANKS UNTIL IMMEDIATELY PRIOR TO MAKING CONNECTIONS. RENEW ALL SEALING RINGS IN ACCORDANCE WITH CHAP.89-7 AND LUBRICATE THEM WITH LIQUID PARAFFIN B.P.(CHAP. 89-1) BEFORE ASSEMBLY.

(1) Drain the inhibiting fluid from the F.C.U.

(2) Where a Mod.1332 F.C.U. is to be fitted, locate the anti-frettage washer on the rear mounting stud (identifed by the figures '.018' engraved on the F.C.U. rear mounting lug), then mount the unit on the studs on the engine and secure it with the three bevelled washers, spring washers and plain nuts.

(3) Connect the L.P. fuel pipe to the F.C.U. fuel inlet adapter, tighten the sleeve nut and lock it with 0.028 in. stainless steel wire (Chap. 89-1).

(4) Insert the No.4 flexible branch pipe through the front of the fireproof bulkhead and assemble the branch pipe support housing and backing plate on to the pipe and manifold adapter.

Fuel control unit - Maintenance practices (cont.)

(5) Insert the manifold adapter spigot into the F.C.U. and assemble the flange on the studs, then fit the bonding lead and secure the adapter with the plain and spring washers and nuts.

(6) Assemble the branch pipe support housing, ensuring that the split Tufnol bushes are correctly positioned, and secure the housing to the fireproof bulkhead with the bolts, spring and plain washers and nuts; do not tighten the nuts fully at this stage.

(7) Connect the flexible branch pipe to the burner connection on No.4 combustion chamber, tighten the union nut taking care not to deform the pipe, then lock it with stainless steel wire.

(8) Tighten the nuts securing the branch pipe support housing to the fireproof bulkhead, then connect the fuel manifold pipe to the adapter, tighten the union nut and lock it with stainless steel wire (Chap. 89-1).

(9) Connect the inlet and outlet pipes to the F.C.U. and fit the inlet/outlet elbow to the H.P. fuel pump as instructed in Chap.73-2.

(10) Fit new washers, secure the drain pipe banjo connection to the F.C.U. with the hollow bolt and tighten it to the torque load specified in Chap.89-3, then lock the bolt with stainless steel wire.

(11) Secure the drain pipe clip to the fireproof bulkhead with the bolt, plain and spring washers and nut.

(12) Connect the ram pressure pipe to the F.C.U. as follows:

(a) On pre-Mod.906 engines, connect the ram pressure pipe to the connection on the upper face of the F.C.U. and secure it with the hose clip.

(b) On Mod.906 engines, fit a new sealing ring to the end of the ram pressure pipe, then insert the pipe into its housing in the lower face of the F.C.U., connect the pipe to the adapter on the air intake casing and tighten the hose clips, secure the pipe clips to the H.P. fuel pump and the bracket on the F.C.U. and connect the bonding lead to the pump inlet/outlet elbow retaining bolt.

(13) Connect the servo pressure pipe to the threaded adapter on the F.C.U., tighten the union nut and lock it with 0.028in. stainless steel wire.

(14) On aircraft featuring a fuel temperature indicating system, refit the temperature bulb to the L.P. filter bowl and reconnect the electrical cable.

CAUTION: DO NOT OVERTIGHTEN THE ELECTRICAL CABLE CONNECTOR OR DAMAGE MAY RESULT TO THE TEMPERATURE BULB/CONNECTOR LOCATING KEY AND/OR THE BULB TERMINAL PINS.

(15) Connect the throttle and H.P. cock control rods to their associated levers on the F.C.U. and check the controls for correct operation and rigging in accordance with the instructions in Chap.76.

CAUTION: THE THROTTLE VALVE LEVER MINIMUM STOP ON THE F.C.U. IS ADJUSTED AND SET ON THE CALIBRATING RIG AND MUST NOT BE DISTURBED IN SERVICE.

(16) Bleed the fuel system as instructed in Chap.73-0, MAINTENANCE PRACTICES.

2. Adjustment/Test

A. Ground run the engine and reset the control interconnection to achieve the datum T.G.T. established in 1.A.(1). Refer to Chap.71-0, Sub-section 4D 'REMOVAL/RE-INSTALLATION GROUND RUN - DRY' and carry out actions A,B,D (T.G.T. only), G and H of RUN 2, re-installation run. For torque pressure acceptance limits, refer to Chap.71-0, Sub-section 4C 'IN-SERVICE GROUND RUN - DRY'.

B. If it was not possible to ground run the engine before the F.C.U. change, establish a datum T.G.T. as follows.

(1) Obtain the datum T.G.T. from the most recent power check, then carry out ground run as specified in A. and interconnect the controls to obtain the datum T.G.T. or the Data-Plate Maximum Dry Take-off T.G.T. plus 10 degrees C.,(on engines with less than 500 flying hours since last test bed declaration, to Data-Plate Maximum Dry Take-off T.G.T.) whichever is higher.

(2) If a datum T.G.T. cannot be obtained, carry out ground run as specified in A. and interconnect the controls to obtain Data-Plate Maximum Dry Take-off T.G.T. plus 10 degrees C. (on engines with less than 500 flying hours since last test bed declaration, to Data-Plate Maximum Dry Take-off T.G.T.). Do not exceed the Operating Limitation Dry Take-off T.G.T.

3. Inspection/Check

A. Examine the F.C.U. generally for signs of fuel leaks and check pipe connections for security and correct wire locking.

B. Check the throttle and H.P. cock control rods for safety and security of attachment to their levers on the F.C.U. Examine the levers for signs of cracks caused by secondary vibration owing to an internal engine defect; this will necessitate removal of the engine for examination.

C. Check the L.P. fuel filter for contamination as instructed in Chap.73-4, 'FUEL FILTER - MAINTENANCE PRACTICES'.

D. Check the F.C.U. for security of attachment to the mounting studs.

Fuel control unit - Maintenance practices (cont.)

E. On pre-Mod.906 engines, check the F.C.U. ram pressure pipe as instructed in Chap.72-0, para.1.A.(10). On Mod.906 engines, check that the 'rattle' pin in the ram pressure pipe drain hole is free to rotate and that the hole is not worn to such an extent that the head of the rattle pin could pass through it. Where Mod.1188 has been embodied, however, the pin passes through a spring-steel sleeve surrounding the pipe and drain hole, thus minimizing fretting of the drain hole.

F. Check the engine controls for full and free movement; refer to Chap. 76-0, 'MAINTENANCE PRACTICES - ENGINE CONTROLS', SERVICING.

G. Ground run the engine as instructed in Chap.71-0, Sub-section 4C 'IN-SERVICE GROUND RUN - DRY', and carry out actions A, B and D.

DESCRIPTION

FUEL FILTER

All fuel entering the engine passes through a low pressure felt filter contained in the flow control unit (fig. 1).

The filter element provides fine filtration and is corrugated to provide the filtration area necessary to keep the pressure drop across the filter within acceptable limits at maximum fuel flow. The element, which is secured into the casing by a central bolt, a spring and a filter retaining plate, seats squarely at the top of the filter bowl to avoid any leakage of unfiltered fuel.

A drain valve incorporated in the head of the central bolt enables samples of fuel for examination to be drawn off, as described under 'Maintenance Practices', without disturbing the filter or allowing dirt or air to enter the fuel system. The drain valve, central bolt and filter cover are each fitted with renewable rubber sealing rings.

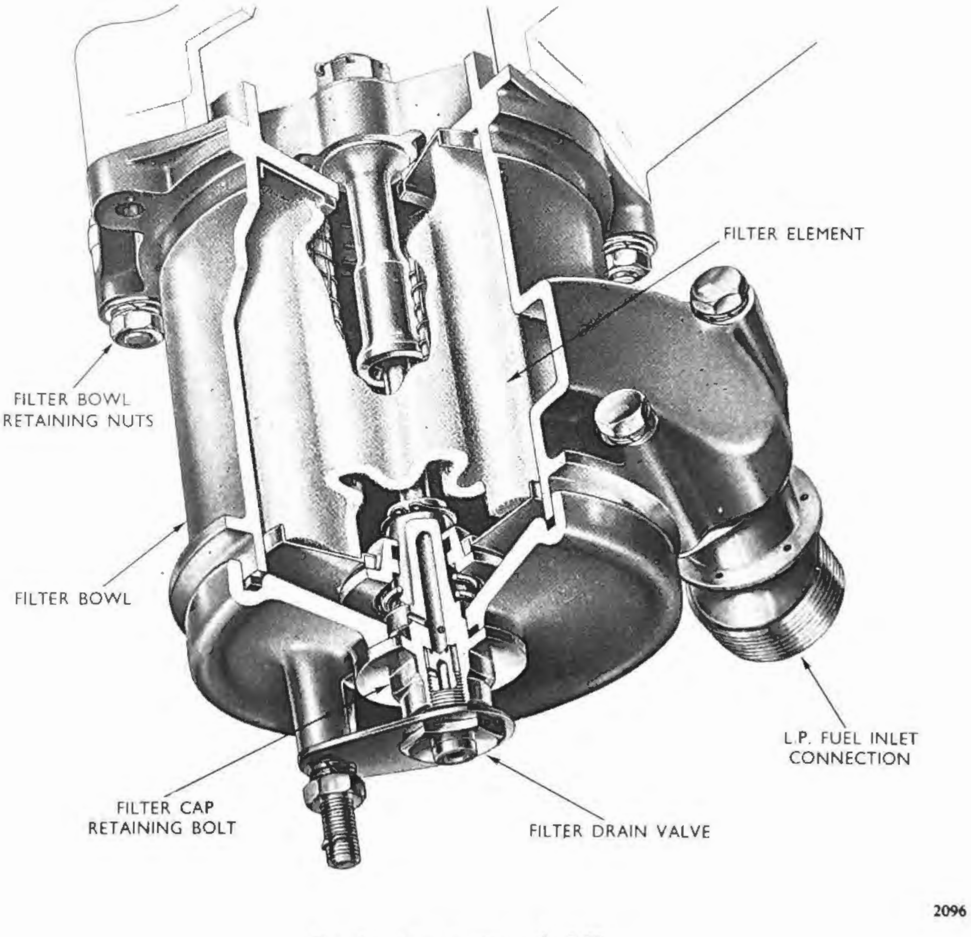

FILTER ELEMENT
FILTER BOWL RETAINING NUTS
FILTER BOWL
L.P. FUEL INLET CONNECTION
FILTER CAP RETAINING BOLT
FILTER DRAIN VALVE
2096

Fig. 1 Low pressure fuel filter

MAINTENANCE PRACTICES

FUEL FILTER

SERVICING

When taking a sample of fuel from the L.P. filter to check for water content and contamination, bleeding of the fuel system can be avoided by observing the following sequence of operations.

Clean the filter casing externally.

Ensure that the H.P. cock is closed and the L.P. cock is open.

Switch ON the tank pumps.

Detach the drain valve lock plate and unscrew the valve by its hexagon to allow approximately 1 pint of fuel to drain into a clean container.

Tighten and lock the drain valve.

Switch OFF the tank pumps.

It is important that if the filter is removed for any reason, the element and sealing washers must be renewed as described below.

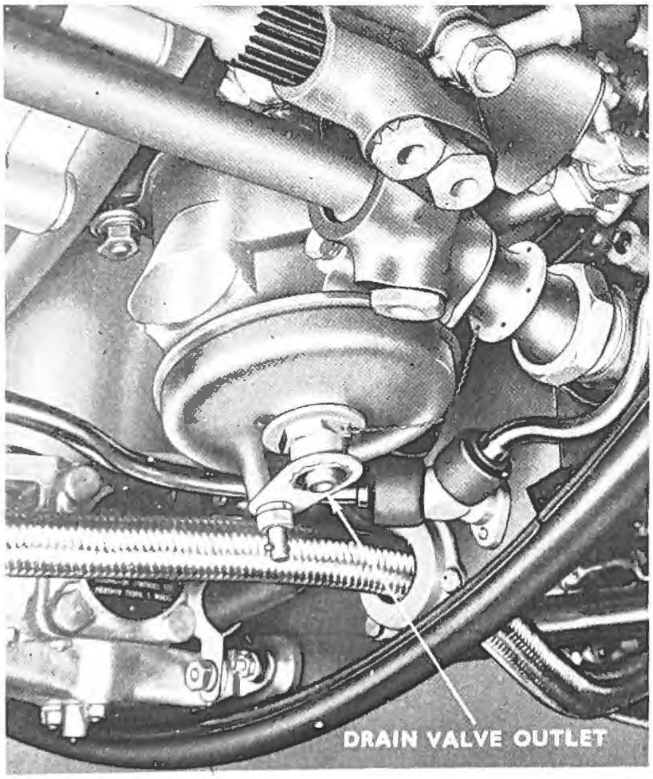


Fig. 201 L.P. fuel filter drain

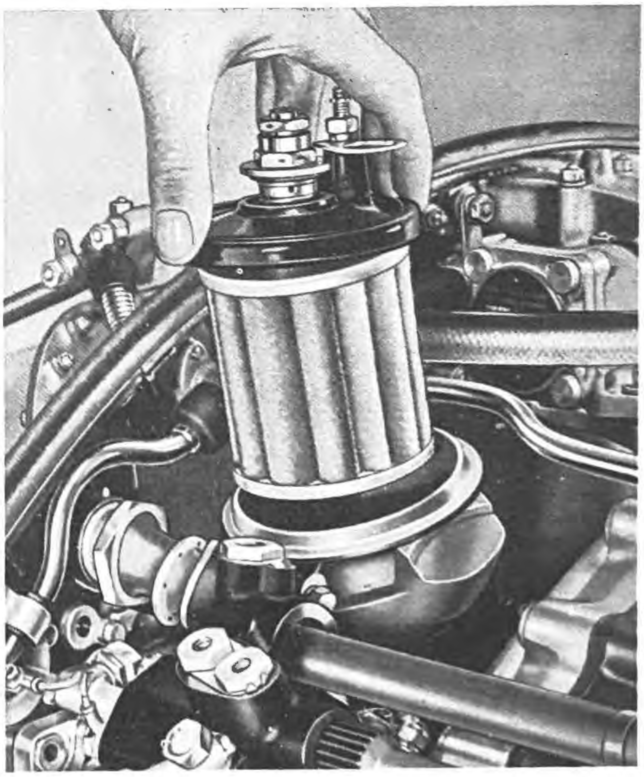


Fig. 202 Fuel filter removal

RENEWAL OF FILTER ELEMENT

Whenever the filter element is removed, or the fuel system is disturbed on the aircraft side of the L.P. cock, and subsequent bleeding of the fuel system warrants removal of the L.P. fuel filter, a new filter element must be fitted.

If the filter is removed for reason of fuel contamination, the source of the trouble must be traced and rectified before fitting the new element.

To remove the filter, proceed as follows:

Ensure that the L.P. cock is closed.

Clean the filter casing externally.

Release the drain valve lockplate, unscrew the valve by its hexagon and allow the fuel to drain.

Unscrew the central retaining bolt and withdraw the assembly.

Slide the element from the retaining bolt.

Before fitting the new element, clean the parts and renew the sealing ring in the filter cover.

Other sealing rings need be renewed only if they are leaking. The drain valve sealing ring can be renewed by completely unscrewing the drain valve; renewal of the retaining bolt sealing ring will necessitate dismantling the cover assembly by removing the circlip with expanding pliers and withdrawing the parts from the bolt. While the parts are dismantled, examine and if necessary renew the sealing ring in the filter retaining boss.

To replace the filter, proceed as follows:

Refit the assembly to the casing, ensuring that the filter element seats squarely at the top end of the casing, and that the tongue on the cover is engaged in the slot in the casing.

Secure the filter cover; tighten the drain valve and secure with the lockplate.

Bleed the fuel system as described in 73-0 under 'Maintenance Practices' before running the engine.

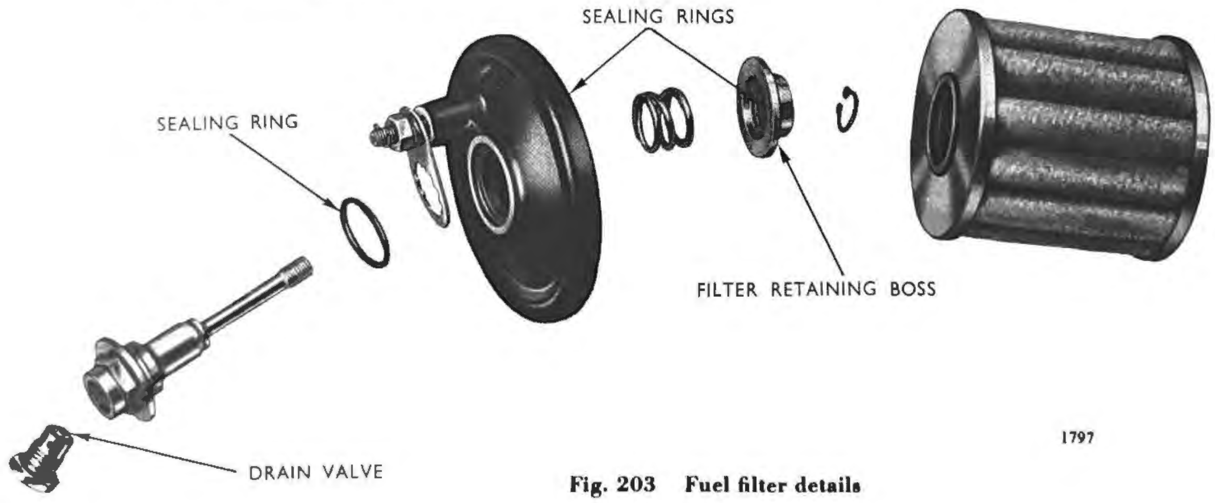


Fig. 203 Fuel filter details

ACTION FOLLOWING SUSPECTED FUEL FILTER ICING

If an icing warning light operates in flight, it is not necessarily due to icing of the L.P. fuel filter. The cause is usually associated with the particular engine operating conditions at the time.

If the warning occurred on take-off, i.e. when the engine was at maximum speed and fuel flow, it could be due to either of the following reasons:

1. Contaminated L.P. fuel filter
2. Resonance of the differential pressure switch

If the warning light came on during cruise, descent or approach, then operation of the fuel heaters would indicate whether the cause is filter icing.

Any false warnings would be more likely to occur at high fuel flows, i.e. at take-off conditions.

Action if warning considered *not* due to icing

1. Change L.P. fuel filter.
2. Ensure that the differential pressure switch is correctly bled.
3. Ground run and check for normal functioning.

Action if warning considered due to icing

Check all drains, and if water is found, continue to drain until the water flow ceases.

Carry out the following, whether water is found or not:

1. If a felt filter is fitted, change the element.
2. If a paper filter is fitted, there is no need to change it as it is non-absorbent.

Note: If the checks are carried out at sub-zero fuel temperature, water may still be present in the form of ice.

IGNITION

For all information relating to the engine igniter system, refer to Chapter 80 — Starting.

DESCRIPTION

HOT AIR VALVE

To protect the engine against the effects of water in the fuel freezing and clogging the filter, provision is made for hot air to be supplied from the second-stage compressor through a hot air gate valve to a heat exchanger which surrounds the engine fuel feed pipe just prior to the filter.

The system is shown diagrammatically in fig. 1. Any accumulation of ice particles in the filter causes an increase in the pressure drop across it which operates the differential pressure switch connected to the cockpit warning light. When the pilot moves the fuel heater switch to the ON position, the solenoid-operated gate valve opens to admit hot air to the heat exchanger. With the switch in the AUTO position, icing in the filter will be automatically countered, the warning light and hot air gate valve operating simultaneously.

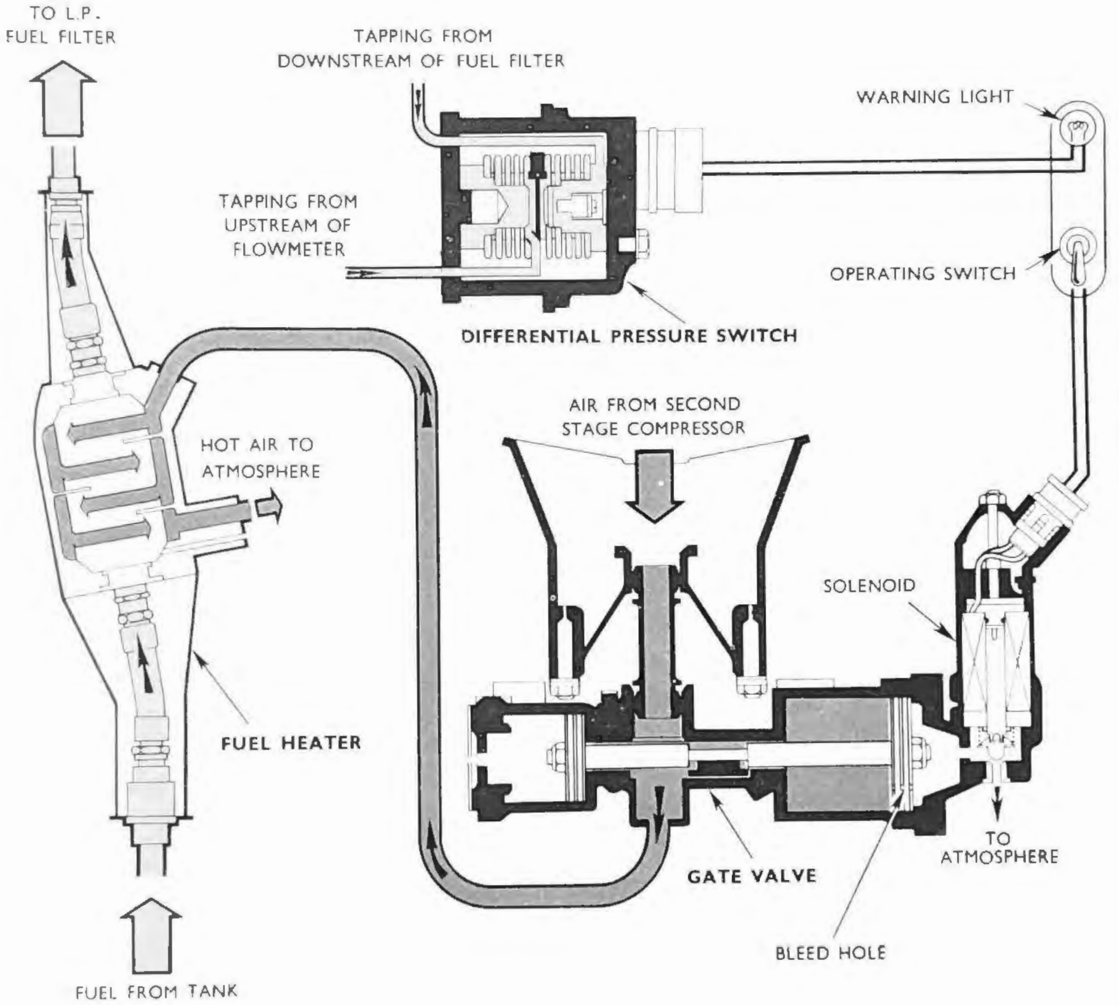


Fig. 1 **Operation of fuel filter de-icing system** 2024

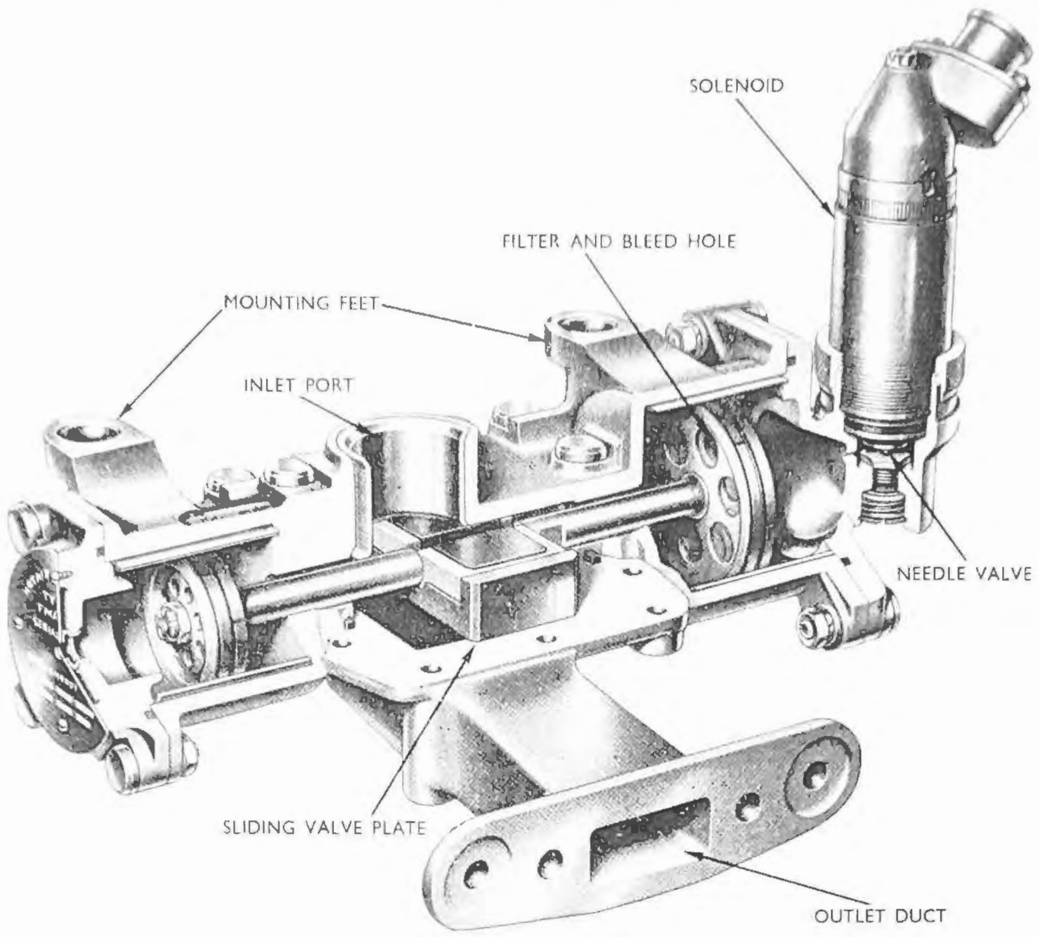


Fig. 2 Hot air valve 1944

The hot air valve illustrated in fig. 2 is mounted on the underside of the compressor intermediate casing, and is operated by air pressure controlled by a needle valve attached to the solenoid.

Two pistons of unequal area are connected together by a rod which carries the carbon sliding gate valve. The head of the smaller piston is subject to atmospheric pressure, and its inner face to compressor air. The large piston incorporates an air bleed, and is therefore subject to compressor air pressure on both sides. Resultant forces hold the sliding valve towards the small piston and no hot air passes to the fuel heater.

When the pressure drop across the fuel filter exceeds 3 p.s.i. the warning light comes on, indicating ice blockage; to relieve this the heater is switched on. This energizes the solenoid which opens the needle valve to allow high pressure air to vent to atmosphere from the head of the large piston. The balance of forces on the two pistons is now upset and the gate valve opens to permit hot air to flow to the heat exchanger. The heat transferred to the fuel flow is carried to the filter, where it melts the trapped ice particles.

The tapping of hot air from the second-stage compressor in this way causes a slight drop in engine power and it is important, therefore, that the gate valve is not open unnecessarily. Checking the gate valve for correct functioning is described in 72-0, 'Adjustment/Test', and 75-1-1, under 'Maintenance Practices'.

MAINTENANCE PRACTICES

HOT AIR VALVE

REMOVAL

The outlet adapter on the rear side of the engine bulkhead must first be removed, together with the tube connection to the fuel heater.

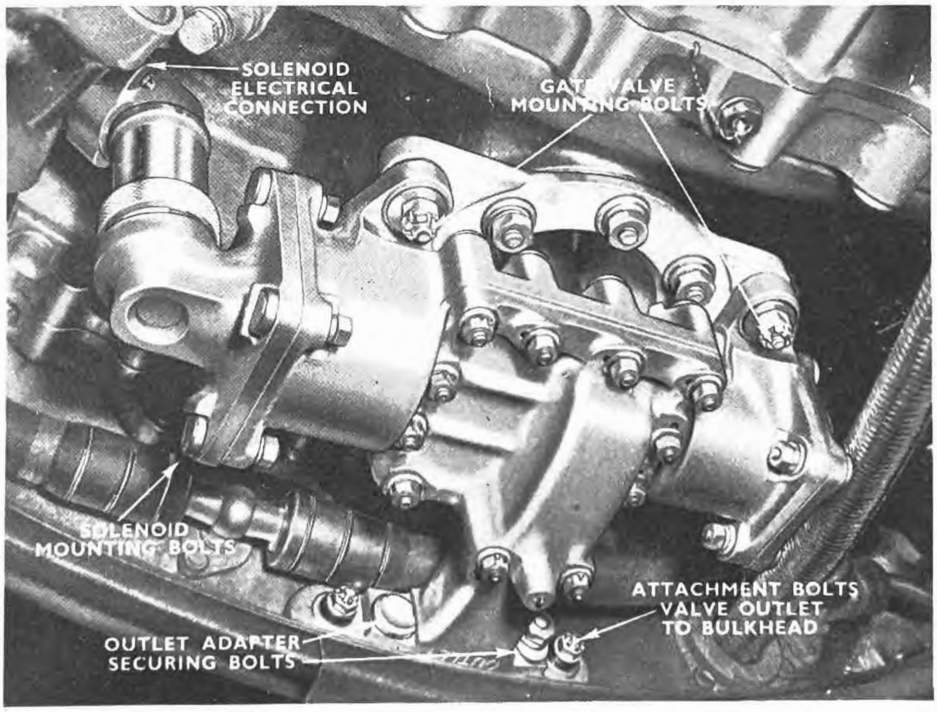
Remove the ¼ in. nuts from the D-headed bolts which pass through the bulkhead, and secure the outlet adapter to the valve outlet connection; one bolt also carries a fuel manifold clip.

Remove the outlet adapter and delivery tube by withdrawing rearwards and downwards.

Remove the split pins, nuts and double-spring washers from the two 2 B.A. bolts attaching the valve outlet connection to the front of the bulkhead, and remove the bolts, together with the friction washers on each side of the bulkhead.

Remove the split pins (Mod. 755 — self-locking nuts) from the four ¼ in. bolts securing the valve body to the support plate on the engine, unscrew the nuts and remove the bolts.

Lever the valve body gently downwards until the rubber ferrules are free, and remove the ferrules. Then push the valve forward to clear the bulkhead flange, and downward to release the seals on the inlet tube. Withdraw the valve, taking care not to damage the seals, and remove the inlet tube.


SOLENOID ELECTRICAL CONNECTION
GATE VALVE MOUNTING BOLTS
SOLENOID MOUNTING BOLTS
ATTACHMENT BOLTS VALVE OUTLET TO BULKHEAD
OUTLET ADAPTER SECURING BOLTS

1275

Fig. 201 Hot air valve connection points

REPLACEMENT

Pre-Mod. 664, smear the piston-ring-type seals on the inlet tube with graphited grease (89-1). Mod. 664 introduces an inlet tube in aluminium and rubber sealing rings; with this mod. embodied, fit new rings, using silicone compound MS.4.

Insert the inlet tube into the valve body and offer the assembly up to the engine at an oblique angle to clear the bulkhead, exerting a steady upward pressure to permit the upper seal to register correctly. Then centralize the assembly and fit the rubber ferrules each side of the valve mounting flange. Fit the bolts and nuts and tighten them, then fit the split pins.

Fit the friction washers on both sides of the bulkhead when replacing the 2 B.A. bolts attaching the valve connection.

Tighten the nuts down on to the steel bushes, double-spring and plain washers until the connection is nipped, then slacken off three castellations before fitting the split pins (Mod. 755 — self-locking nuts).

When fitting the outlet tube, smear the seals with graphited grease.

SERVICEABILITY CHECK

With the engine running at Minimum Constant Speeding r.p.m. and the fuel filter heater switched on, ensure that hot air discharges to atmosphere. The discharge should cease entirely when the heater is switched off.

HOT AIR VALVE SOLENOID REMOVAL

Disconnect the electrical lead at the socket connection.

Remove the four 2 B.A. nuts and bolts securing the whole assembly to a flange joint on the valve body, and withdraw the assembly.

Do not attempt to unscrew the knurled ring on the solenoid.

REPLACEMENT

Renew the sealing ring in the flange joint.

Offer up the solenoid assembly to the valve body and tighten the four securing bolts and nuts.

Reconnect the electrical cable.

SERVICEABILITY CHECK

With the engine stationary, operate the hot air valve switch and listen for the 'click' of the solenoid, then carry out the hot air valve serviceability check.

CHAPTER 76 - ENGINE CONTROLS

LIST OF ROLLS-ROYCE EFFECTIVE PAGES

This chapter consists of the following pages

CHAPTER SECTION AND PAGE	DATE
List of effective pages	
(R) 1/2	Jan.85
76 Table of contents	
1	Sept.80
76-0	
1	Sept.30/58
2	May 31/58
3	May 10/62
4	Sept.30/58
5	Sept.30/58
6	July 31/60
201	May 31/58
202	Oct.31/58
203	Oct.79
204	Oct.79
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208	Jan.84
208A	Dec.81
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208D	Dec.81
209	July 31/60
210	July 31/60
(R) 211	Jan.85
212	Apr.75
213	July 84
214	July 84
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DESCRIPTION

CONTROL SYSTEM

The engine is controlled by three systems:

The throttle, r.p.m. and water/methanol controls

The fuel datum control

The H.P. cock and feathering controls.

The first two systems are interconnected. The arrangement of controls on the engine is illustrated in fig. 1.

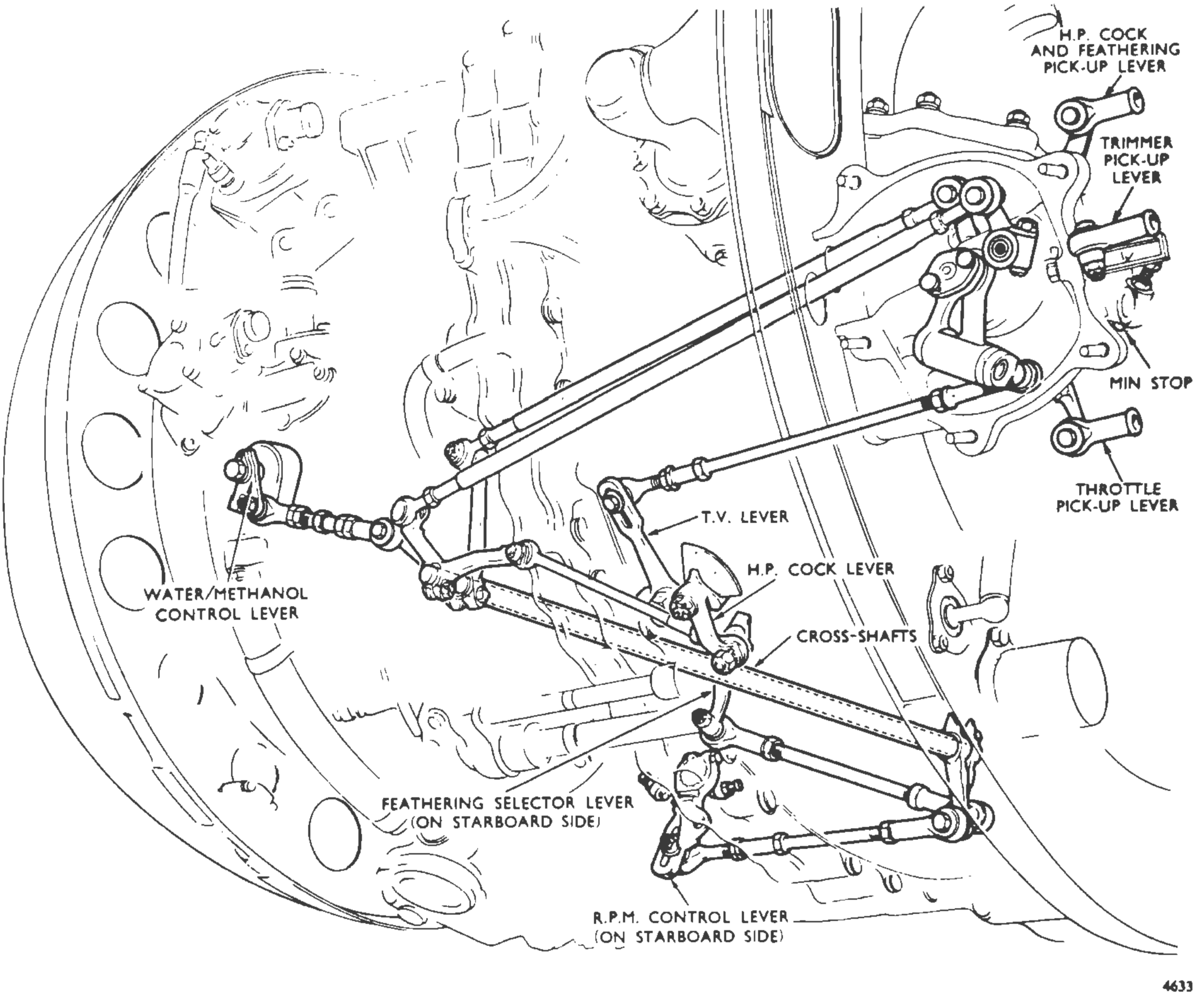

H.P. COCK AND FEATHERING PICK-UP LEVER
TRIMMER PICK-UP LEVER
MIN STOP
THROTTLE PICK-UP LEVER
T.V. LEVER
H.P. COCK LEVER
CROSS-SHAFTS
WATER/METHANOL CONTROL LEVER
FEATHERING SELECTOR LEVER (ON STARBOARD SIDE)
R.P.M. CONTROL LEVER (ON STARBOARD SIDE)
4633

Fig. 1 Engine controls

THROTTLE, R.P.M. AND WATER/METHANOL CONTROLS

The control of fuel flow and the selection of engine r.p.m. are mechanically interconnected to give single lever control of engine power at any given outside air temperature.

The arrangement of the interconnection is shown schematically in fig. 2. Full traverse of the pilot's throttle lever always results in full traverse of the r.p.m. selector lever. The r.p.m. control is inoperative below Flight Idling r.p.m., however, and at engine speeds below this, r.p.m. is dependent on the throttle valve opening.

The linkage to the water/methanol unit is part of the throttle valve/r.p.m. system; the oil valve permitting the operation of the water/methanol unit is opened only when the pilot's throttle lever has passed the Maximum Continuous position and approaches the Take-off position.

FUEL DATUM CONTROL

Fig. 2 also shows in principle how the effective leverage on the throttle valve lever can be reduced if required. This provision enables the fuel flow to be reduced or 'trimmed' proportionately for the whole engine range to prevent overheating above the desired operating temperature should the air mass flow be reduced by a higher-than-standard outside air temperature.

The device which achieves this result is housed in the engine control box (described later).

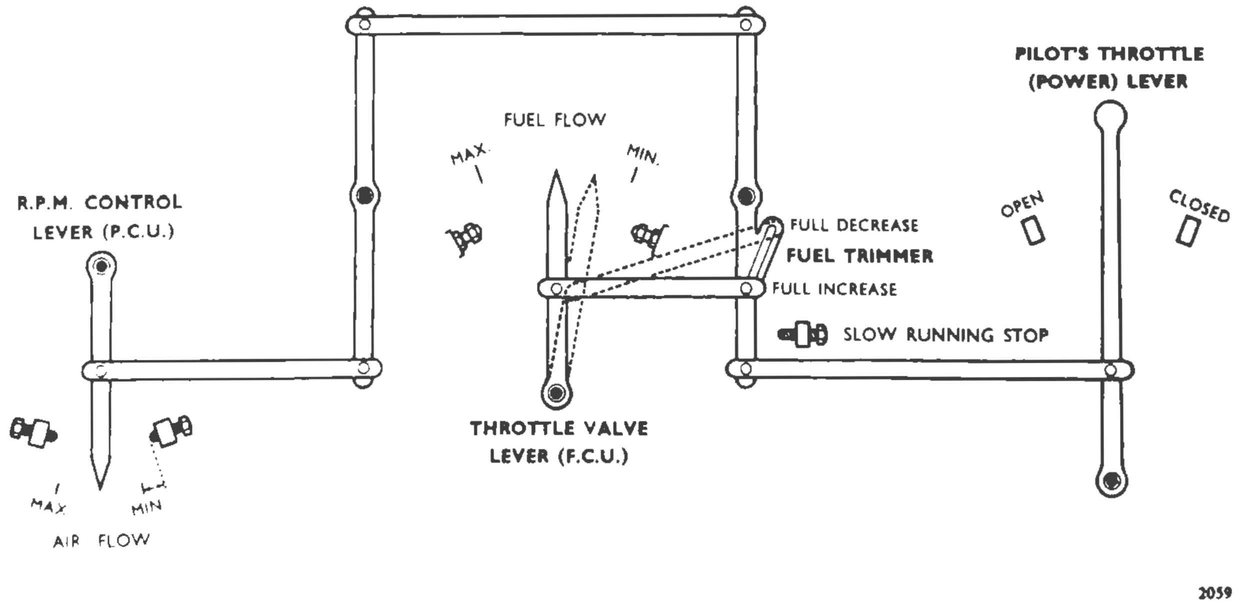


Fig. 2 Interconnection of engine controls

H.P. COCK AND FEATHERING CONTROLS

The H.P. cock on the flow control unit (on the port side of the engine) is connected with the controls cross-shaft. The cross-shaft connects on the same (port) side of the engine with the H.P. cock pick-up lever on the engine control box, and on the starboard side with the feathering selector lever on the propeller controller unit (P.C.U.). This arrangement is shown in fig. 1.

Four positions of the H.P. cock pick-up lever are provided for, as follows:

H.P. cock pick-up lever	**H.P. cock lever**	**Feathering selector lever**
1. Fully rearward	Open	Lock Out (High Stop Withdrawal)
2. Intermediate rearward position	Open	Auto run
3. Intermediate forward position	Shut	Unfeather (UF)
4. Fully forward	Feather	Feather (F)

To reach positions 1 or 4, the pilot's lever must be pushed forward or rearward through gates in the quadrant. These movements of the lever are communicated to the P.C.U., but toggling action of the linkage and dead movement of the H.P. cock result in the F.C.U. valve remaining 'Open' and 'Shut' respectively.

The engine control box has its forward limit stop for the pilot's pick-up lever engraved F (Feather) and the rearward limit stop engraved LO (Lock Out). The forward and rearward intermediate positions are indicated by a plate attached to the side of the control box, marked S (Shut) and O (Open) respectively.

The effect on the propeller of selecting Feather and Lock Out on the controls is described in Chapter 61.

ENGINE CONTROL BOX

The pick-up points at which the engine and aircraft control systems are connected are on the engine control box on the port side of the engine (fig. 3).

The H.P. cock and throttle pick-up levers are operated from the cockpit by direct mechanical linkage. The fuel trimmer pick-up lever is moved by an electric actuator, controlled from the cockpit by a two-way centre-off switch the fuel datum control.

The actuator is power plant mounted and is connected to the pick-up lever on the engine control box by an aircraft linkage system which includes a transmitter for a position indicator in the cockpit.

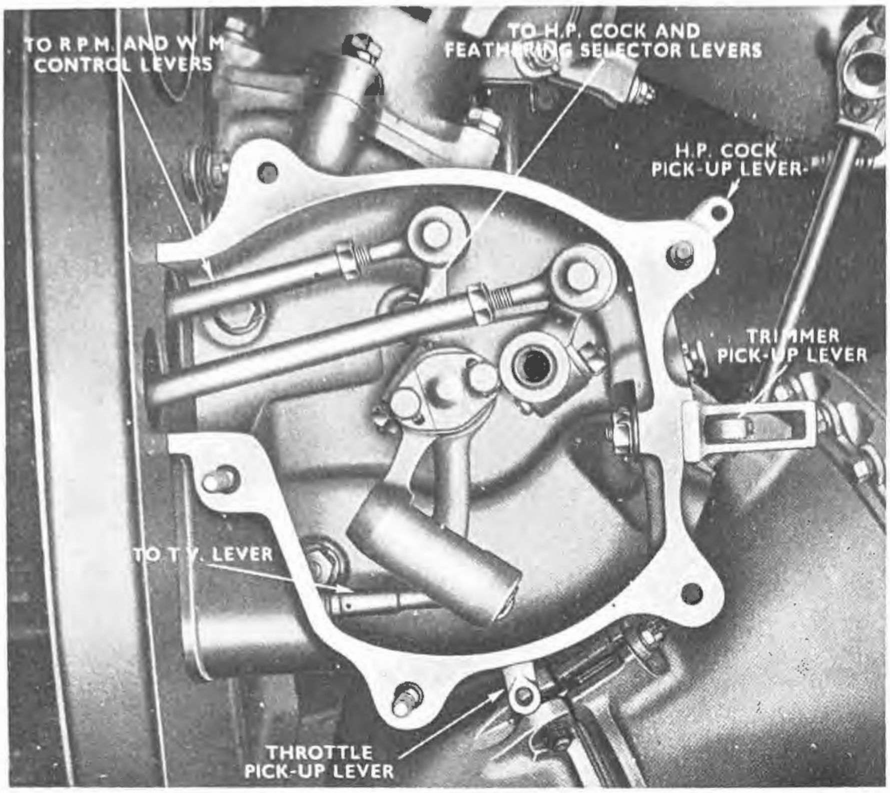


Fig. 3 Engine control box

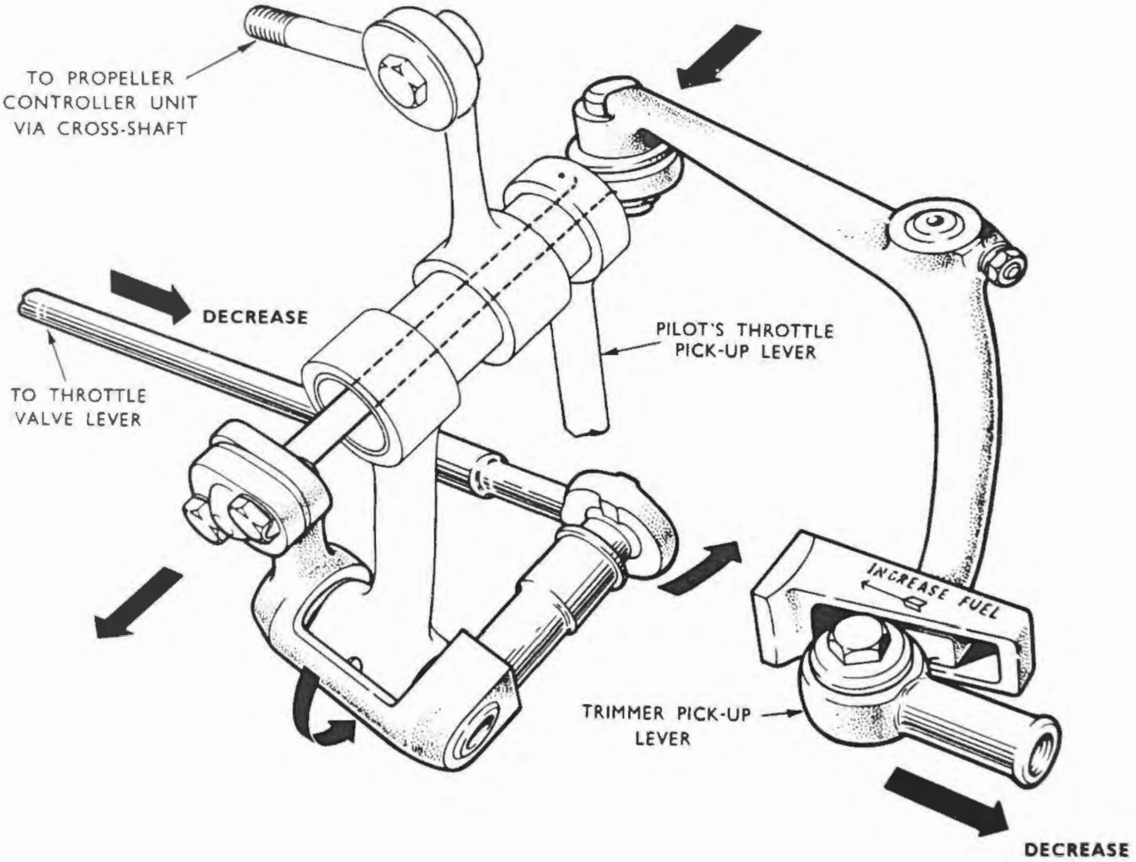

TO PROPELLER CONTROLLER UNIT VIA CROSS-SHAFT
DECREASE
TO THROTTLE VALVE LEVER
PILOT'S THROTTLE PICK-UP LEVER
INCREASE FUEL
TRIMMER PICK-UP LEVER
DECREASE

Fig. 4 Fuel trimmer mechanism

The mechanism in the control box which alters the position of the throttle valve in relation to the pilot's throttle lever and r.p.m. selector lever includes a differential compound lever; the operating principle is illustrated in fig. 4.

For a given position of the trimmer pick-up lever, i.e. for a given position of the fuel datum position indicator, the percentage reduction from maximum fuel flow is approximately constant at all power conditions. This follows because a given amount of trimmer pick-up lever movement closes off the throttle valve lever more at high r.p.m. and power than at low, as illustrated in fig. 5.

CONTROL RODS AND END FITTINGS

A conventional system of adjustable rods and levers is used to transmit control movement to the various engine units. Transfer of movement from one side of the engine to the other is by concentric cross-shafts supported by bearings on the compressor front casing.

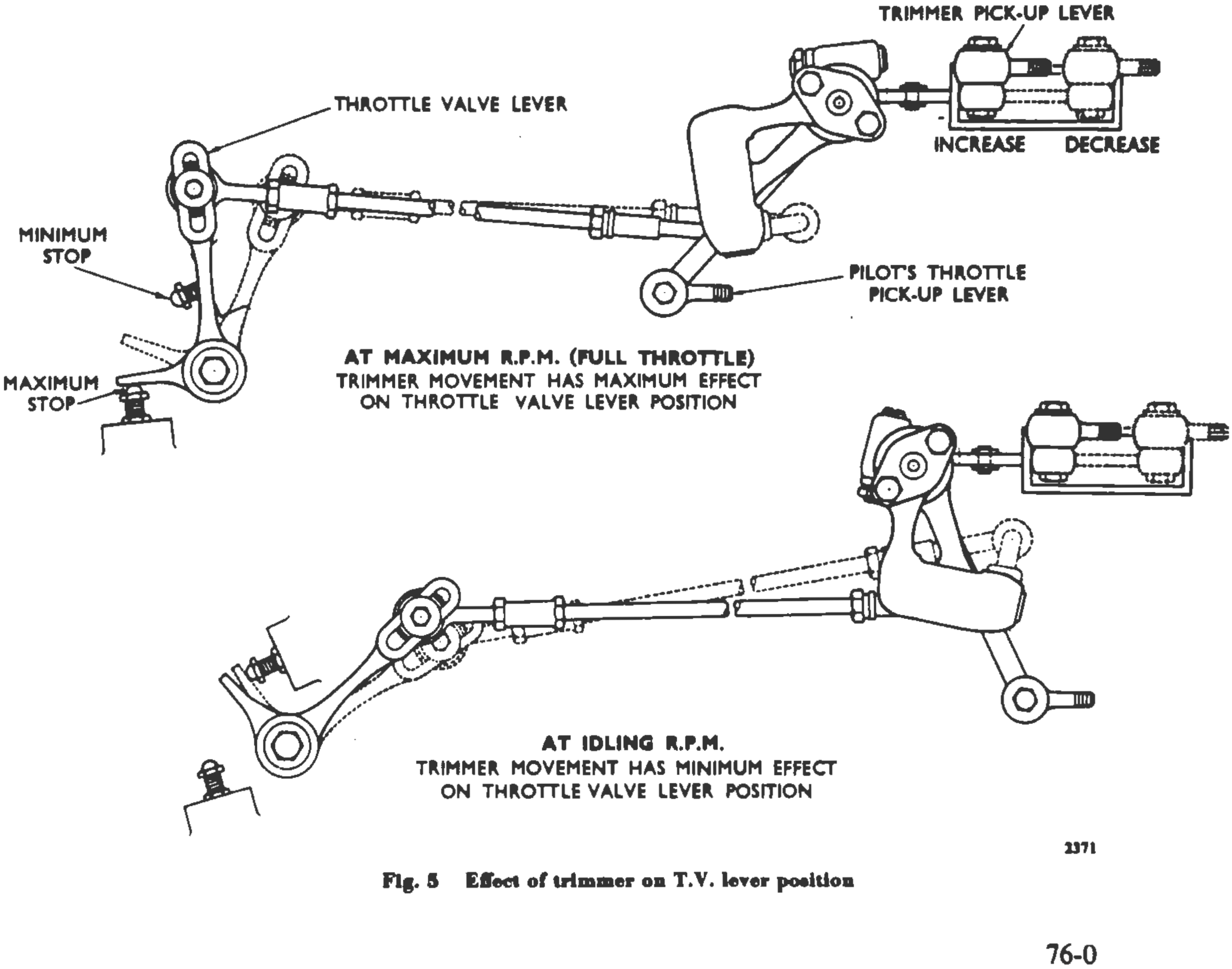

TRIMMER PICK-UP LEVER
THROTTLE VALVE LEVER
INCREASE
DECREASE
MINIMUM STOP
PILOT'S THROTTLE PICK-UP LEVER
MAXIMUM STOP
AT MAXIMUM R.P.M. (FULL THROTTLE)
TRIMMER MOVEMENT HAS MAXIMUM EFFECT ON THROTTLE VALVE LEVER POSITION
AT IDLING R.P.M.
TRIMMER MOVEMENT HAS MINIMUM EFFECT ON THROTTLE VALVE LEVER POSITION
2371

Fig. 5 Effect of trimmer on T.V. lever position

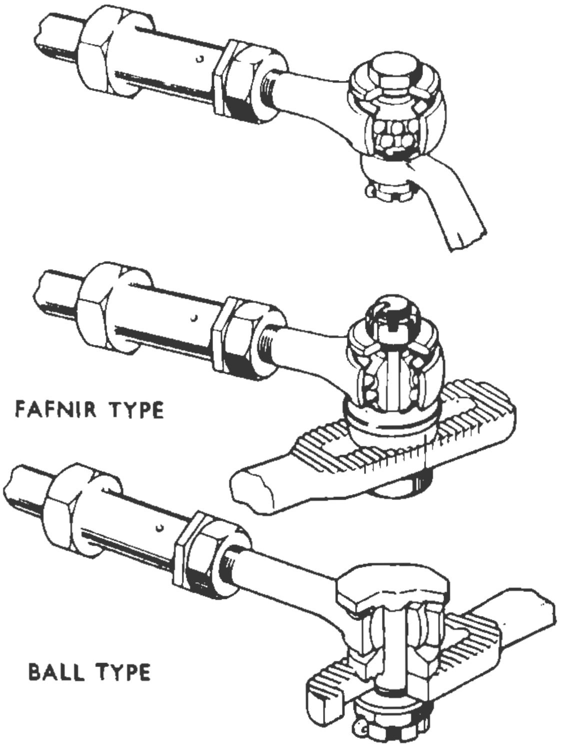


Fig. 6 Control rod end fittings

The rods immediately connecting the water/methanol, r.p.m. selector and throttle valve levers are left and right-hand threaded. The end fittings, illustrated in fig. 6, may be of the ball or Fafnir type; that on the throttle valve lever can be repositioned along the slot in its lever and then locked in position on the serrated faces.

The controls are grease-lubricated and grease nipples are provided on the control box and on the inner cross-shaft. The Fafnir end fittings do not normally require lubrication during the overhaul life of the engine.

MAINTENANCE PRACTICES

CONTROL SYSTEM

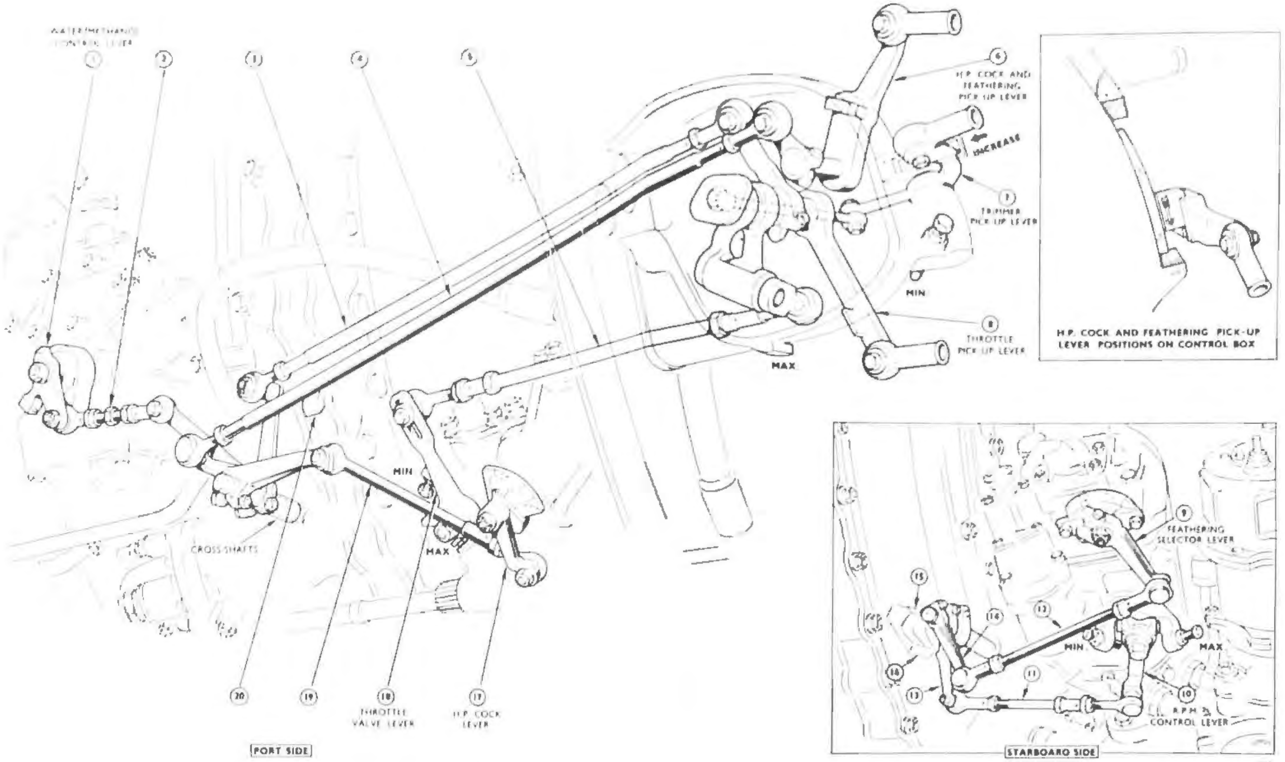


Fig. 201 Engine controls

KEY TO ENGINE CONTROLS DIAGRAM

1. Water/methanol control lever
2. Control rod—outer cross-shaft to water/methanol control lever
3. Control rod—throttle pick-up lever to outer cross-shaft lever
4. Control rod—H.P. cock pick-up lever to inner cross-shaft lever
5. Control rod—differential compound lever to throttle valve lever
6. H.P. cock and feathering pick-up lever
7. Trimmer pick-up lever
8. Throttle pick-up lever
9. Feathering selector lever
10. R.p.m. control lever
11. Control rod—outer cross-shaft lever to r.p.m. control lever
12. Control rod—inner cross-shaft lever to feathering selector lever
13. Lever—outer cross-shaft
14. Lever—inner cross-shaft

15 & 16. Limit stops—outer cross-shaft lever

17. H.P. cock lever
18. Throttle valve lever
19. Control rod—inner cross-shaft lever to H.P. cock lever
20. Setting block.

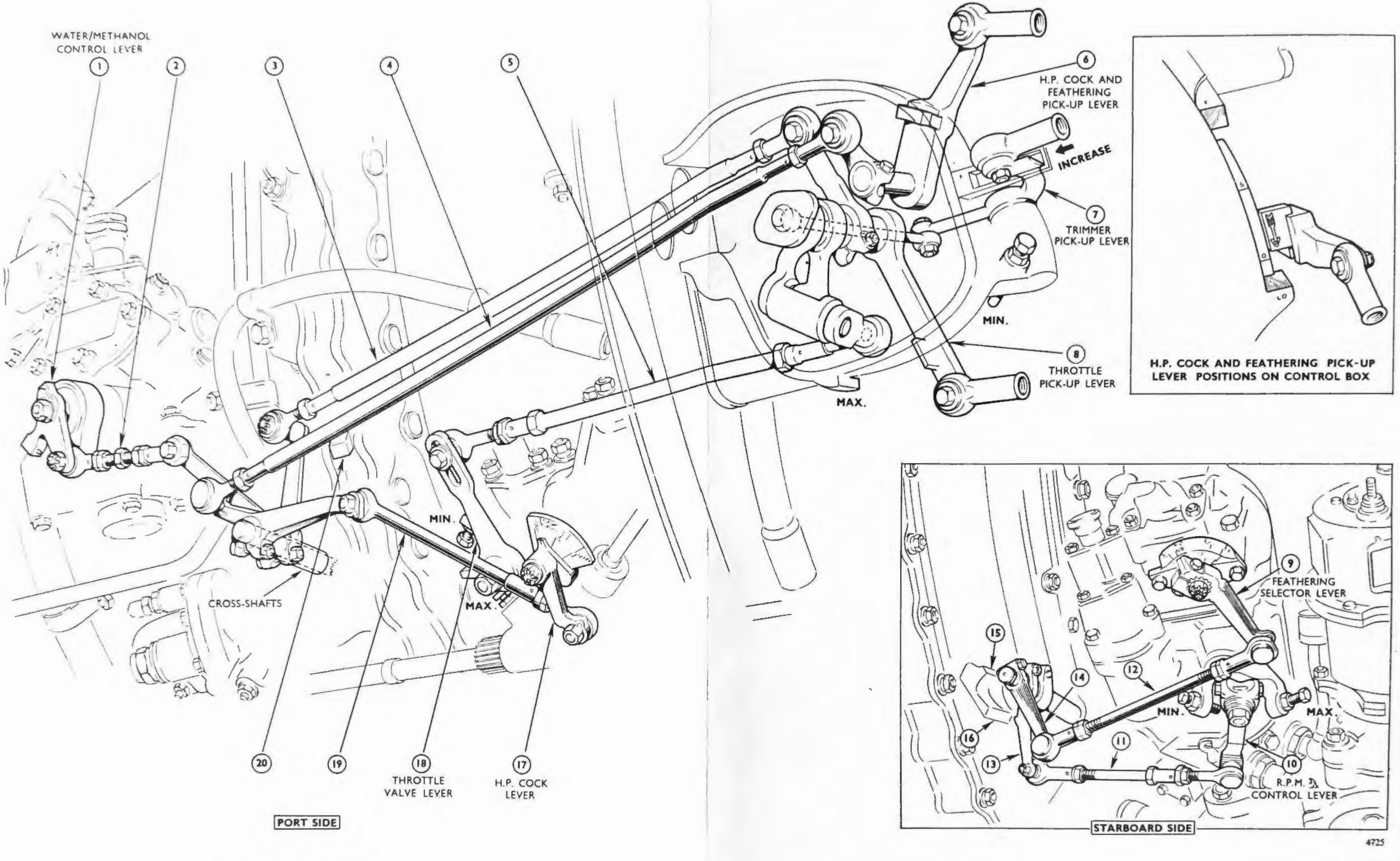


Fig. 201 Engine controls

KEY TO ENGINE CONTROLS DIAGRAM

1. Water/methanol control lever
2. Control rod—outer cross-shaft to water/methanol control lever
3. Control rod—throttle pick-up lever to outer cross-shaft lever
4. Control rod—H.P. cock pick-up lever to inner cross-shaft lever
5. Control rod—differential compound lever to throttle valve lever
6. H.P. cock and feathering pick-up lever
7. Trimmer pick-up lever
8. Throttle pick-up lever
9. Feathering selector lever
10. R.p.m. control lever
11. Control rod—outer cross-shaft lever to r.p.m. control lever
12. Control rod—inner cross-shaft lever to feathering selector lever
13. Lever—outer cross-shaft
14. Lever—inner cross-shaft

15 & 16. Limit stops—outer cross-shaft lever

17. H.P. cock lever
18. Throttle valve lever
19. Control rod—inner cross-shaft lever to H.P. cock lever
20. Setting block.

MAINTENANCE PRACTICES

ENGINE CONTROLS

SERVICING

Functional check

With the engine stopped and the propeller on its ground fine pitch stop, carry out the functional check of cockpit engine controls for free and full movement as follows.

Pilot's throttle lever — Open fully
Fuel datum — Trim FULL INCREASE
Fuel datum — Trim FULL DECREASE
Pilot's throttle lever — Move to IDLE,.lift, pull back and release. (The lever should return to the IDLE position)
Booster pumps — Check OFF
H.P. cock — Select FEATHER
H.P. cock — Select LOCK OUT (*Fokker*) or EMER. OUT (*Fairchild*)
H.P. cock — Select SHUT

These checks are recommended in the above sequence to ensure that the H.P. cock and throttle are not both open at the same time, as this would complete the auto-feathering circuit to the feathering pump motor.

Finally, press the feathering button and pull out after three seconds; the feathering pump should operate but the propeller should not commence to feather. This check proves the feathering pump and ensures that the P.C.U. control piston has not stuck in the feather position.

Inspection

At the recommended period given in 89-4, inspect the engine control rods for possible distortion and fouling as well as for security and correct locking; lubricate the ball ends, cross-shafts and control box with the grease specified in 89-1. If the F.C.U. or P.C.U. levers are found to be cracked, the engine should be rejected for suspected internal damage (see 71-0, 'Trouble shooting, Rough running').

STATIC CHECKS AND ADJUSTMENTS

Check the control static settings after engine installation, before an engine serviceability ground run, following unit change or any other change or disturbance to the control system, and as required when investigating a defect.

When adjusting engine controls the control rods may be disconnected at the aircraft bulkhead; reconnect, check and lock the complete system when the engine controls are satisfactorily set.

The sequence to be used during adjustment of the controls is given later in tabular form combined with the static setting checks. Make adjustments only when absolutely necessary, and always follow with a static settings check, a check for security (male threads 'in safety') and satisfactory locking, a static feathering and unfeathering check whenever the H.P. cock and feathering control system has been disturbed or adjusted, and a serviceability ground run (71-0,'Adjustment/test')

To prevent propeller auto-feathering with the engine stationary when the H.P. cock and throttle levers are open together, trip the appropriate circuit breaker.

Static feathering and unfeathering check

Whenever any part of the H.P. cock and feathering control system has been disturbed or adjusted, the following check must be made to prove correct functioning of the feathering linkage.

> **Note:** Motoring or ground running to return displaced oil to the tank, and possible oil flooding of the engine, can both be avoided by fitting the special oil by-pass equipment. (See 'Engine, Adjustment/test, Propeller system functional checks'.)

Ensure adequate engine oil available, check electrical supply on, booster pumps and water/methanol off, and propeller at ground fine pitch, and gust lock lever locked. Then:

Throttle	Fully CLOSED
H.P. cock	SHUT
Feathering button	PRESS
	Check propeller pitch does not change
H.P. cock	FEATHER
	Check propeller feathers fully
H.P. cock	LOCK OUT *(Fokker)* EMER. OUT *(Fairchild)*
Feathering button	PRESS
	Check propeller unfeathers to ground fine pitch stop, pull out feathering button, ensure feathering pump off, and return H.P. cock to SHUT.

If the special oil by-pass equipment has not been fitted, observe the usual oil level precautions and ground run the engine for 10 minutes at 11,000 r.p.m. to return displaced oil to the tank.

If the check is not completely satisfactory, re-check control static settings. If these are correct, investigate and rectify any defects in the propeller control system (71-0, 'Trouble shooting, Propeller system functional defects', and aircraft manual).

Auto-synchronizers

Ensure that the synchro system is on datum before checking the control system. Use great care in throttle handling, as undue force at either end of the travel can disturb the datum setting of the synchronizer.

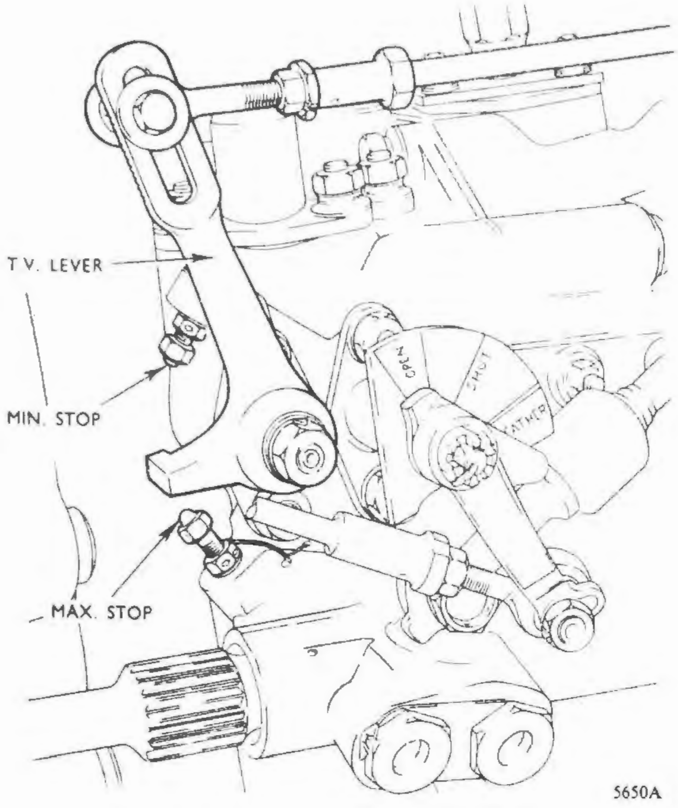


Fig. 202 T.V. lever and stops

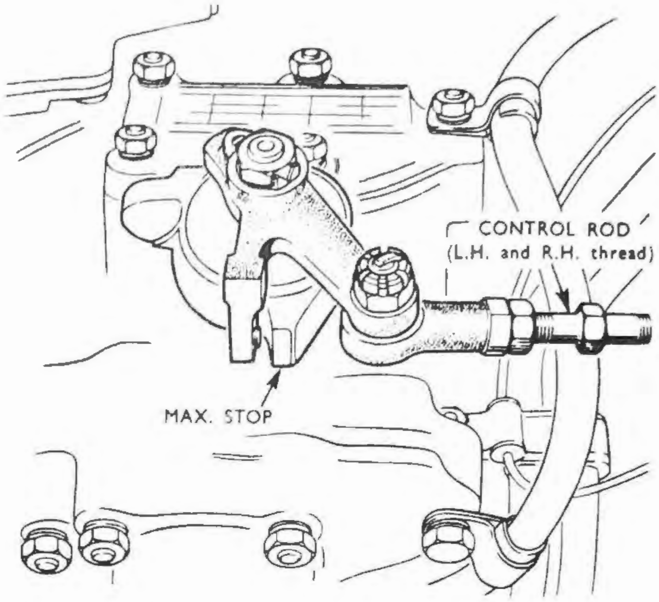
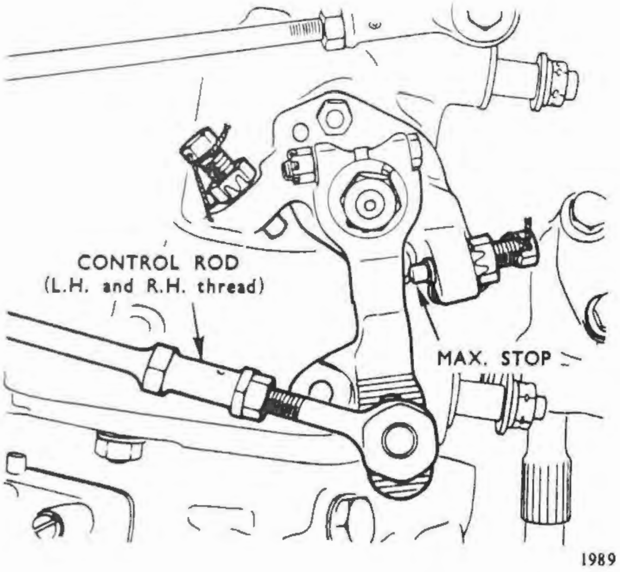
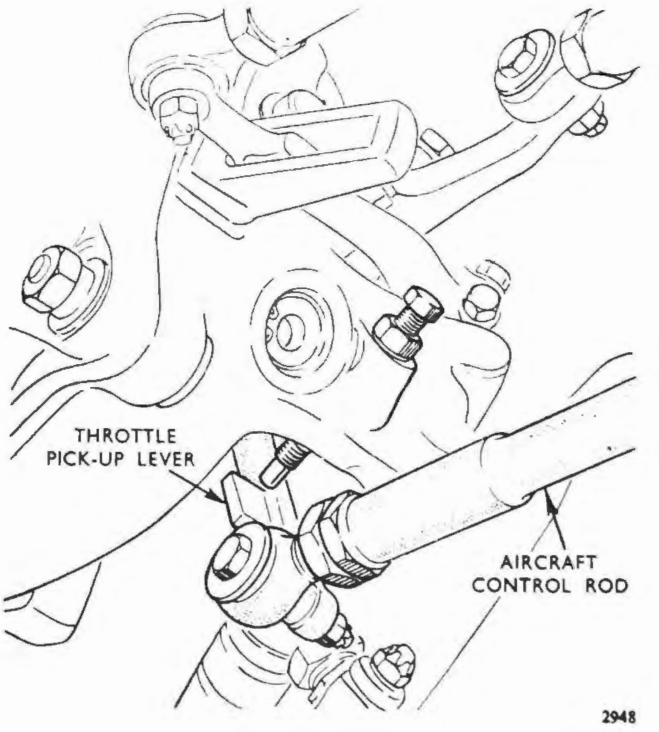


Fig. 204 Water/methanol lever and stops



R.p.m. control lever and stops
Fig.203



Control box adjustable stop
Fig.205

If there is no 'spring' at either end of the cockpit lever travel, it may indicate that the controls are off datum, and checks at Take-off or Static Ground Idling engine speed may not then be representative. In these circumstances, reset the synchronizer and check again for throttle 'spring'. If throttle 'spring' is inadequate when the synchronizer is known to be on datum, adjust the aircraft controls before proceeding further.

Stops and clearances

To ensure that positive contact is obtained on those levers which are required to touch their stops, a 0.0015 in. feeler gauge should be interposed between the lever and its stop; when the linkage is correctly adjusted the feeler will just be nipped when the lever is moved to its extreme position.

Note that when checking the water/methanol maximum stop and T.V. lever minimum stop clearances, a greater tolerance is allowed than when setting these clearances.

Fuel datum controls

The performance of the engine at ambient conditions where trimming is required depends very largely on a high standard of accuracy of fuel datum control setting, including the position indicator. It is recommended that the static checks called for, and the adjustments required to rectify any defects, are strictly observed.

SET THE CONTROLS AFTER UNIT REPLACEMENT

On the replacement unit concerned, obtain the initial settings given below; disconnect the aircraft controls at the bulkhead, if desired, during setting. Finally, reconnect, check and lock the whole system.

Flow control unit

CAUTION: DO NOT ADJUST THE FUEL CONTROL UNIT MINIMUM STOP. THE THROTTLE VALVE LEVER/FUEL CONTROL UNIT MINIMUM STOP IS RIG-SET TO THE APPROPRIATE CLEARANCE TO OBTAIN AN ACCEPTABLE ENGINE IDLING FUEL FLOW.

Use an initial T.V. lever length corresponding to that of the unit previously removed, or if this setting is not known or is believed to be incorrect, use a T.V. lever length of four serrations (pre-Mod.1706) or 2 serrations (Mod.1706) out from the mid-position and proceed as follows.

Trip the appropriate circuit breaker to prevent propeller auto-feathering when the pilot's throttle and H.P. cock levers are open together.

With the trimmer pick-up lever at the full increase position in the control box quadrant (for Mk.536-7P and 536-7R set to 85 per cent) and with the throttle pick-up lever contacting the control box adjustable stop and the H.P. cock open, proceed as follows.

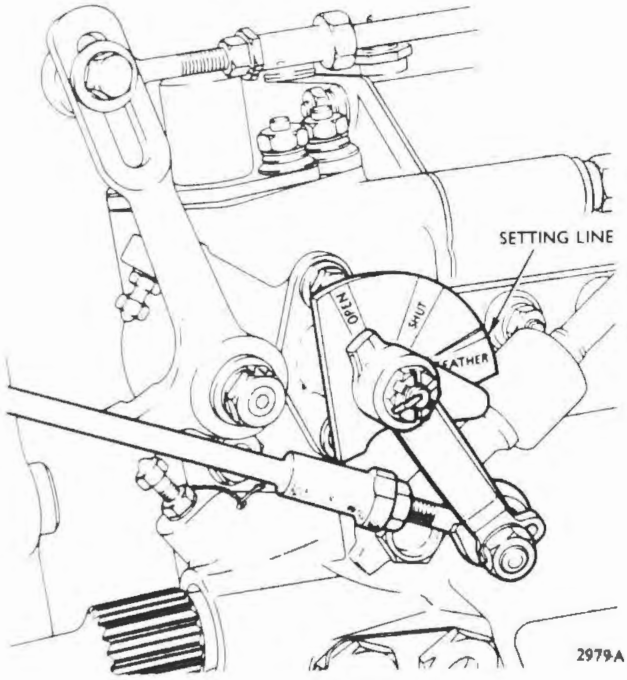
Note: To facilitate any subsequent adjustment, set the control box adjustable stop at the mid-point of its range, i.e. projecting to:

Pre-Mod.1138	-	0.050 in.
Mod.1138 (S.B.Da72-151) but pre-Mod.1523	-	0.090 in.
Mod.1523 (S.B.Da73-55)	-	0.110 in.

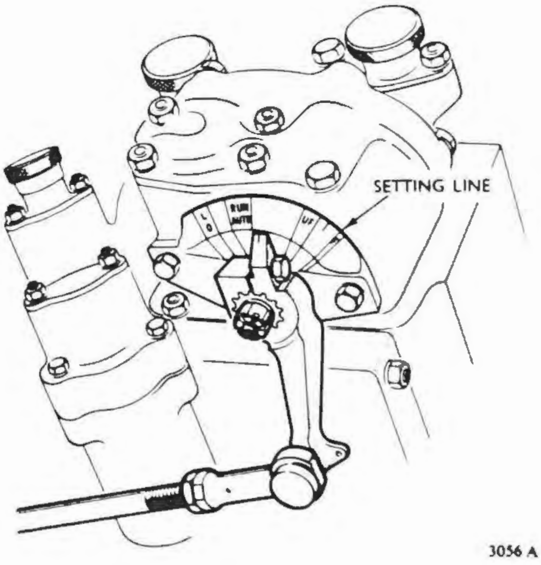
(1) connect the control rod between the control box and the T.V. lever.

(2) Adjust the rod length so that the T.V. lever/F.C.U. minimum stop clearance is:

Pre-Mod.1138	-	0.100 in.
Mod.1138 but pre-Mod.1523		0.120 in.
Mod.1523	-	0.140 in.



H.P. cock lever
Fig.206



P.C.U. feathering selector lever
Fig.207

Move the throttle pick-up lever to contact the control box maximum stop, retaining the trimmer pick-up lever at the full increase position (for Mk.536-7P and 536-7R reset to 100 per cent).

Adjust the F.C.U. maximum stop to obtain a clearance of at least 0.050 in. between it and the T.V. lever.

With the H.P. cock pick-up lever contacting the 'F' limit stop on the control box and with the unit backlash taken up by rotating the F.C.U./H.P. cock lever towards OPEN, connect the control rod between the cross-shaft and F.C.U. lever with the rod length adjusted to position the F.C.U. lever on the short (cold setting) line of the FEATHER markings (see Fig.206) or within 0.010 in. (1 degree) of it towards the SHUT markings.

Note: Disregard the 'Set hot, Check hot' instruction on the F.C.U. quadrant plate.

Carry out the controls static checks as tabulated later in this section, reconnect the aircraft controls at the bulkhead, if neceesary.

Propeller controller unit

The r.p.m. control lever maximum stop is rig set to give maximum r.p.m. when the P.C.U. lever contacts it; proceed as follows.

Trip the appropriate circuit breaker to prevent propeller auto-feathering when the pilot's throttle and H.P. cock levers are open together.

With the H.P. cock and throttle pick-up levers at their fully open positions:

(i) Connect the control rod from the cross-shaft to the mid-position of the serrated P.C.U. r.p.m. control lever.

(ii) Adjust the rod length so that the r.p.m. control lever just contacts its maximum stop.

(iii) Adjust the maximum stop to obtain at least 0.050 in. clearance between lever and stop.

Move the throttle pick-up lever to contact the control box adjustable stop and ensure there is a clearance of at least 0.050 in. between the r.p.m. control lever and the minimum stop.

Note: The minimum stop may be adjusted back to the limit of its adjustment to prevent any possible interference on subsequent adjustment.

With the H.P. cock pick-up lever contacting the 'F' limit stop on the control box and with the unit backlash taken up by rotating the unit lever towards L.O. (Lock Out), connect the control rod between the cross-shaft and the P.C.U. feathering selector, with the rod length adjusted to position the P.C.U. lever on the 'F' band line nearer to UF (see fig.207) or within 0.015 in. (1 degree) of it towards the UF markings.

Carry out the controls static checks as tabulated later in this section before locking the controls.

Water/methanol unit

Operation of the water/methanol unit depends on the control lever being opened fully, i.e. the control lever/maximum stop clearance being correct; proceed as follows.

Trip the appropriate circuit breaker to prevent propeller auto-feathering when the pilot's throttle and H.P. cock levers are open together.

Positioning the H.P. cock and the throttle pick-up levers at their fully open positions, connect the rod from the cross-shaft to the water/methanol control lever and adjust its length to obtain the following clearance between the lever and its maximum stop:

Mod.927 units : 0.150 to 0.155 in.

Mod.927 units with their casing stop lug filed; clearance as above increased by the figure marked on casing minus 0.0325 in.

Pre-Mod.927 : 0.100 to 0.110 in.

When making this adjustment, ensure that the throttle pick-up lever is moved gradually to contact the maximum stop on the control box as 'slamming' the control can result in error.

Verify that the control static settings are correct before locking the controls.

ENGINE CONTROLS - MAINTENANCE PRACTICES

1. General

It is possible that stiction of the controls cross-shaft assembly, caused by hardening of the lubricant grease, could occur in certain extreme operating conditions. Where stiction is encountered, remove the cross-shaft assembly and clean the shafts in accordance with the instructions given in para.2. It is also recommended that the frequency of the lubricating periods be increased.

2. Removal/Installation

A. Remove the cross-shaft assembly.

NOTE: (1) Pre-Mod.995 (S.B.No.Da76-4) assemblies do not have a clamping ring and the outer cross-shaft adjusting washer is located on the right-hand side of the cross-shaft.

(2) The terms 'left-hand' and 'right-hand' are used to describe the position of parts and assemblies when viewed from the rear of the engine.

(1) Remove the retaining bolts from the control rod end-couplings at the cross-shaft control levers on the right and left-hand side of the engine.

(2) Remove the securing bolts from the levers on the inner and outer cross-shafts at the left-hand side of the engine only.

(3) Remove the grease nipple from the left-hand end of the inner cross-shaft, Mod.1594 (S.B. No.Da76-12), to facilitate removal of the levers.

CAUTION: OBSERVE THE LOCATION OF ALL CROSS-SHAFT WASHERS; THE ADJUSTING WASHERS MUST BE FITTED IN THEIR ORIGINAL POSITIONS ON RE-ASSEMBLY TO MAINTAIN THE EXISTING END FLOAT CLEARANCES.

(4) Remove the inner cross-shaft lever, key and distance washer.

(5) Remove the outer cross-shaft lever, key and adjusting washer.

(6) Remove the securing bolt from the outer cross-shaft clamping ring, located on the left-hand side of the cross-shaft.

(7) From the right-hand side of the engine withdraw the inner cross-shaft from the bore of the outer cross-shaft and remove the adjusting washer.

NOTE: If difficulty is experienced when withdrawing the inner cross-shaft, both shafts may be removed together and separated after removal from engine.

(8) Withdraw the outer cross-shaft from the left-hand support bush on the compressor casing, collect the clamping ring, then withdraw the shaft completely from the centre and right-hand support bushes.

B. Clean the cross-shafts

(1) Remove the grease nipple from the right-hand end of the inner cross-shaft to facilitate cleaning.

(2) Carefully remove all traces of lubricant grease from the outer surfaces and the inner bores of both cross-shafts, using the solvent specified in Chap.89-1.

(3) Examine the inner and outer cross-shaft bearing journals for corrosion, scores or scratches; carefully remove any corrosion and/or minor scores and scratches using fine abrasive tape.

(4) Refit the grease nipple to the right-hand end of the inner cross-shaft.

C. Install the cross-shaft assembly

(1) Smear the outer cross-shaft with grease, specified in Chap.89-1, and fit it through the right-hand and centre support bushes on the compressor casing; fit the clamping ring onto the cross-shaft then push the shaft through the left-hand support bush.

(2) Align the clamping ring on the outer cross-shaft and fit the securing bolt, washer and nut; torque tighten the nut to the loading specified in Chap.89-3.

(3) Fit the original adjusting washer to the left-hand end of the outer cross-shaft.

(4) Locate the key in the cross-shaft keyway, fit the control lever and secure it with the bolt, new tabwasher and nut; torque tighten the nut to the loading specified in Chap.89-3.

(5) Using feeler gauges, check that the outer cross-shaft end float clearance is within the limits specified in the 'Cross-shaft end float clearances' table.

NOTE: A slight adjustment can be made by slackening the clamping ring and lever securing bolts, and then retightening them.

CROSS-SHAFT END FLOAT CLEARANCES (engine cold)			
Pre-Mod.995		Mod.995	
INNER SHAFT	OUTER SHAFT	INNER SHAFT	OUTER SHAFT
0.015 in.min. 0.030 in.max.	0.065 in.min. 0.080 in.max.	0.010 in.min. 0.020 in.max.	0.003 in.min. 0.008 in.max.

NOTE: The clearances specified in the 'Cross-shaft end float clearances' table are permissible worn clearances only. If the clearances cannot be obtained, refer to the appropriate overhaul manual for further instructions.

(6) Rotate the outer cross-shaft in the support bushes and check that it is free from stiction. If it is satisfactory bend up the locking tabs on the lever securing bolt tabwasher.

(7) Fit the original adjusting washer onto the inner cross-shaft, against the lever; smear the shaft with the grease specified in Chap.89-1, and fit it into the bore of the outer cross-shaft.

(8) Fit the distance washer to the left-hand end of the inner cross-shaft.

(9) Locate the key in the cross-shaft keyway, fit the control lever and secure it with the bolt, new tabwasher and nut; torque tighten the nut to the loading specified in Chap.89-3.

(10) Using feeler gauges, check that the inner cross-shaft end float clearance is within the limits specified in the 'Cross-shaft end float clearances' table.

(11) Rotate the inner cross-shaft in the bore of the outer cross-shaft and check that it is free from stiction. If it is satisfactory bend up the locking tabs on the lever securing bolt tabwasher.

(12) Refit the grease nipple to the left-hand end of the inner cross-shaft (Mod.1594 cross-shaft only).

(13) Connect the control rods to the cross-shaft levers and fit the retaining bolts to the end-couplings; torque tighten the nuts to the loading specified in Chap.89-3, and fit the split-pins.

(14) Lubricate the cross-shaft assembly with the grease specified in Chap.89-1, using the appropriate grease gun.

Engine controls - Maintenance practices (cont.)

3. Inspection/Check

A. Function check the engine controls, then effect the controls static checks and the static feathering and unfeathering checks as detailed in Chap.76.

B. Effect the propeller system functional static checks as detailed in Chap.71-0.

4. Adjustment/Test

A. Effect an engine serviceability ground run as detailed in Chap.71-0.

CONTROL STATIC CHECKS

To be carried out with the engine cold (i.e. at least 20 minutes after shut-down):

(a) after engine installation
(b) before an engine serviceability ground run
(c) following unit change or other change or disturbance to the control system
(d) as required when investigating a defect.

H.P. COCK, FEATHERING AND LOCK OUT CONTROLS

ACTION	CHECK	RECTIFICATION
Move pilot's H.P. cock lever to LOCK OUT (*Fokker*) or EMER. OUT (*Fairchild*)	H.P. cock pick-up lever contacts engine control box LO stop, with pilot's lever still clear of its pedestal stop	Adjust aircraft controls to ensure pick-up lever contacts stops; ensure clearance at LOCK OUT (*Fokker*) or EMER. OUT (*Fairchild*) end of pilot's lever travel (see aircraft manual)
Move pilot's H.P. cock lever to FEATHER	H.P. cock pick-up lever contacts engine control box F stop	
Select H.P. cock SHUT	H.P. cock pick-up lever is opposite S mark on engine control box	Eliminating backlash in aircraft linkage by moving pilot's lever towards FEATHER, adjust quadrant SHUT stop plate to contact pilot's lever.
Select H.P. cock OPEN	H.P. cock pick-up lever is opposite O mark on engine control box	Eliminating backlash in aircraft linkage by moving pilot's lever towards LOCK OUT, adjust quadrant OPEN stop plate to contact pilot's lever
Disconnect control at aircraft bulkhead. Select H.P. cock FEATHER (pick-up lever contacting F stop on engine control box)	(1) Cross-shaft end of H.P. cock control rod is clear of compressor setting block by 0.075 in. to 0.125 in.	Adjust control rod between cross-shaft and H.P. cock pick-up lever on engine control box
	(2) H.P. cock lever on F.C.U. is on the short (cold setting) line of the FEATHER markings, or is within 0.010 in. of it towards the SHUT markings (see fig. 206) Note: Disregard the 'Set hot, Check hot' instruction on the F.C.U. quadrant plate	Adjust control rod between cross-shaft and unit, with unit backlash taken up by rotating F.C.U. lever towards OPEN
	(3) Feathering selector lever on P.C.U. is on F band line nearer to UF, or is within 0.015 in. of it towards the UF markings (see fig. 207)	Adjust control rod between cross-shaft and unit, with unit backlash taken up by rotating P.C.U. lever towards LO (Lock Out)

CONTROL STATIC CHECKS (cont.)

ACTION	CHECK	RECTIFICATION
Select H.P. cock SHUT (pick-up lever opposite S mark)	(1) H.P. cock lever is within SHUT markings on F.C.U. (2) Feathering selector lever is within UF markings on P.C.U.	Suspect distorted control levers and/or linkage
Select H.P. cock OPEN (pick-up lever opposite O mark)	(1) H.P. cock lever is within OPEN markings on F C.U. (2) Feathering selector lever is within RUN AUTO markings on P.C.U.	
Select H.P. cock LOCK OUT (pick-up lever contacting LO stop on engine control box)	(1) H.P. cock lever is within OPEN markings on F.C.U. (2) Feathering selector lever is within LO markings on P.C.U.	

CONTROL STATIC CHECKS (cont.)

THROTTLE, R.P.M. AND WATER/METHANOL CONTROLS

ACTION	CHECK	RECTIFICATION
Open pilot's throttle fully	Throttle pick-up lever contacts control box maximum stop	Ensure engine synchronizers are on datum
Close pilot's throttle fully	Throttle pick-up lever contacts control box adjustable stop	Ensure adequate 'spring' available on cockpit controls (see aircraft manual)
Trim full increase	Clearance between trimmer pick-up lever and maximum stop on control box quadrant is between 0.005 in. and 0.007 in. for pre-Mod.1371 and Mod.1371 control boxes (0.020 in. for Mk.535,536,551 and variants) 0.070 in. to 0.072 in. for Mk.528-7E engines incorporating Mod.1850. Fuel datum indicator is at 100 per cent.	If clearance incorrect: Adjust pick-up control rod and bulk-head lever length to obtain required clearance
	NOTE: These clearances will also apply where Mod.1371 control boxes are fitted but the increased angular range is not required.	
Trim full decrease	(1) Trimmer pick-up lever just contacts minimum stop on control box quadrant. Fuel datum indicator is at 0 per cent. (2) Clearance between trimmer pick-up lever and minimum stop on control box quadrant is between 0.095 in. and 0.100 in. where Mod.1371 control boxes are fitted but the increased fuel trim angular range is not required. Fuel datum indicator is at 0 per cent. NOTE: This setting is to cater for the situation where pre-Mod.1371 and Mod.1371 engines are installed in the same aircraft.	If fuel datum indication incorrect: (a) Ensure that pick-up lever clearance is correct (b) Adjust link to transmitter lever and adjust transmitter lever length until indications are satisfactory

THROTTLE, R.P.M. AND WATER/METHANOL CONTROLS (cont.)

ACTION	CHECK	RECTIFICATION
Disconnect throttle and trimmer controls at aircraft bulkhead if desired. Move throttle and trimmer pick-up levers to their maximum positions, with H.P. cock open. If aircraft controls connected, trip appropriate circuit breaker to prevent propeller auto-feathering	(1) T.V. lever/F.C.U. maximum stop clearance is at least 0.050 in. (For replacement unit, see 'Set the controls after unit replacement').	Adjust F.C.U. maximum stop to obtain required minimum clearance.
	(2) Clearance between cross-shaft lever on left-hand side and compressor setting block is 0.235 in. to 0.265 in.	(a) Adjust P.C.U. maximum stop to just contact P.C.U. lever (b) Adjust rod between control box and cross-shaft to obtain required clearance. NOTE: It may be necessary to adjust length of P.C.U. and w/m control rods to achieve this. (c) Adjust P.C.U. control rod until lever just contacts P.C.U. maximum stop. (d) Carry out checks (3), (4) and (5).
	(3) P.C.U. lever length is set at mid-position.	(a) Adjust P.C.U. maximum stop to just contact lever. (b) Set lever length to mid-position. (c) Adjust P.C.U. control rod until lever just contacts P.C.U. maximum stop. (d) Carry out checks (4) and (5).
	(4) P.C.U. lever/maximum stop clearance is at least 0.050 in. (For replacement unit, see 'Set the controls after unit replacement').	Adjust P.C.U. maximum stop to obtain required minimum clearance.

ACTION	CHECK	RECTIFICATION
	(5) Water/methanol control lever/maximum stop clearance is at least 0.150 in. (For replacement unit, see 'Set the controls after unit replacement').	Adjust control rod between water/methanol control lever and cross-shaft to bring clearance within checking limits.
Move throttle pick-up lever to contact control box adjustable stop, retaining trimmer at full increase (for Mk.536-7P and 536-7R engines set to 85 per cent trim) with the H.P. cock OPEN.	(1) Control box adjustable stop projects: Pre-Mod.1138, 0 to 0.100 in. Mod.1138, 0 to 0.175 in. Mod.1523, 0 to 0.225 in. T.V. lever/F.C.U. minimum stop clearance is: Pre-Mod.1138 0.090 in. to 0.110 in. Mod.1138 0.110 in. to 0.130 in. Mod.1523 0.130 in. to 0.150 in. For replacement unit, see 'Set the controls after unit replacement'.	(1) Ensure no interference by P.C.U. minimum stop. Adjust control box adjustable stop; permissible range of adjustment Pre-Mod.1138 0 to 0.100 in. projection Mod.1138 0 to 0.175 in. projection Mod.1523 0 to 0.225 in. projection to set T.V. lever/F.C.U. minimum stop clearance to: Pre-Mod.1138, 0.100 in. Mod.1138 0.120 in. Mod.1523, 0.140 in. If the above projections/clearances cannot be obtained, adjust control box adjustable stop to the mid-point of its range, i.e. projecting to: Pre-Mod.1138 - 0.050 in. Mod.1138 but pre-Mod.1523 - 0.090 in. Mod.1523 - 0.110 in.

THROTTLE, R.P.M. AND WATER/METHANOL CONTROLS (cont.)

ACTION	CHECK	RECTIFICATION
		(2) Adjust F.C.U. maximum stop to just contact T.V. lever with throttle fully open and trimmer at full increase (for Mk.536-7P and 536-7R engines set to 85 per cent trim). (3) Adjust T.V. lever length as required, i.e. shorten to reduce T.V. lever/F.C.U. minimum stop clearance and vice versa. (a) For each 0.020 in. or part of 0.020 in. T.V. lever/F.C.U. minimum stop clearance is greater or less than: Pre-Mod.1138, 0.100 in. Mod.1138, 0.120 in. Mod.1523, 0.140 in. adjust T.V. lever length one serration. (b) Adjust rod between T.V. lever and control box so that T.V. lever just contacts F.C.U. maximum stop, with the throttle fully open and trimmer at full increase (for Mk.536-7P and 536-7R engines set to 85 per cent trim). (c) Adjust control box adjustable stop, permissible range of adjustment: Pre-Mod.1138 0.to 0.100 in. projection Mod.1138 0 to 0.175 in. projection Mod.1523 0 to 0.225 in. projection

ACTION	CHECK	RECTIFICATION
		To obtain clearance of: Pre-Mod.1138, 0.100 in. Mod.1138, 0.120 in. Mod.1523, 0.140 in. between T.V. lever and F.C.U. minimum stop with throttle closed and trimmer at full increase (for Mk.536-7P and 536-7R engines set to 85 per cent trim)
Move throttle pick-up lever to fully open position and fuel trimmer to full increase (all engine Mks.)	(2) T.V. lever/F.C.U. maximum stop clearance	Adjust F.C.U. maximum stop so that T.V. lever/maximum stop clearance is at least 0.050 in., with throttle fully open and trimmer at full increase.
	(3) P.C.U. lever/minimum stop clearance is at least 0.050 in.	P.C.U. minimum stop may be adjusted back to limit of its adjustment to prevent possible interference on subsequent adjustment.

DESCRIPTION

THERMOCOUPLES AND HARNESS

Gas temperatures are not consistent over a cross section of the main flow through the turbine, as zones or layers of dissimilar temperatures can exist simultaneously, and therefore it is necessary to sample gas temperature from a number of points well distributed over a cross section of the flow.

The Dart 520 series engine pyrometer system incorporates twelve thermocouples which are positioned radially around the nozzle box and protrude into the main gas stream at the turbine intermediate stage. Metering of the temperatures from twelve points across a turbine stage enables the cockpit gauge to register an accurate mean turbine gas temperature.

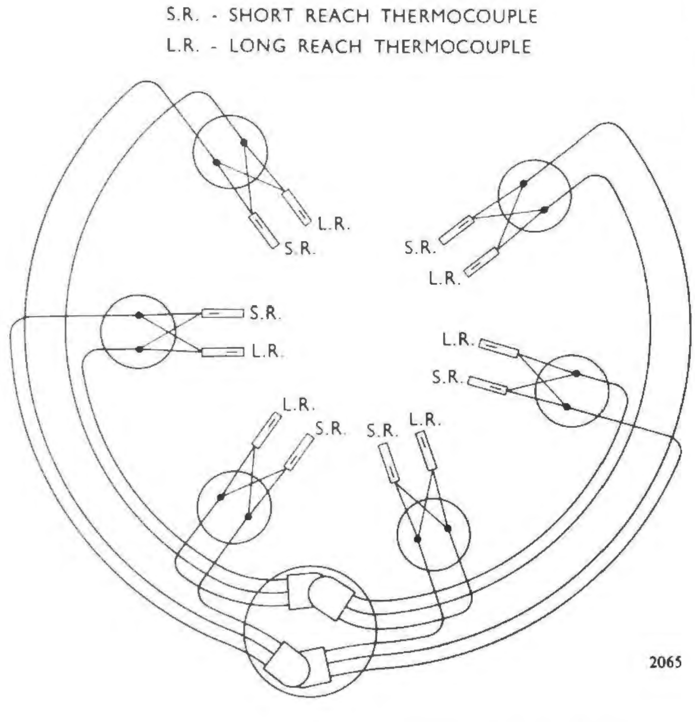

S.R. - SHORT REACH THERMOCOUPLE
L.R. - LONG REACH THERMOCOUPLE
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Fig. 1 Pyrometer wiring diagram (viewed from front of engine)

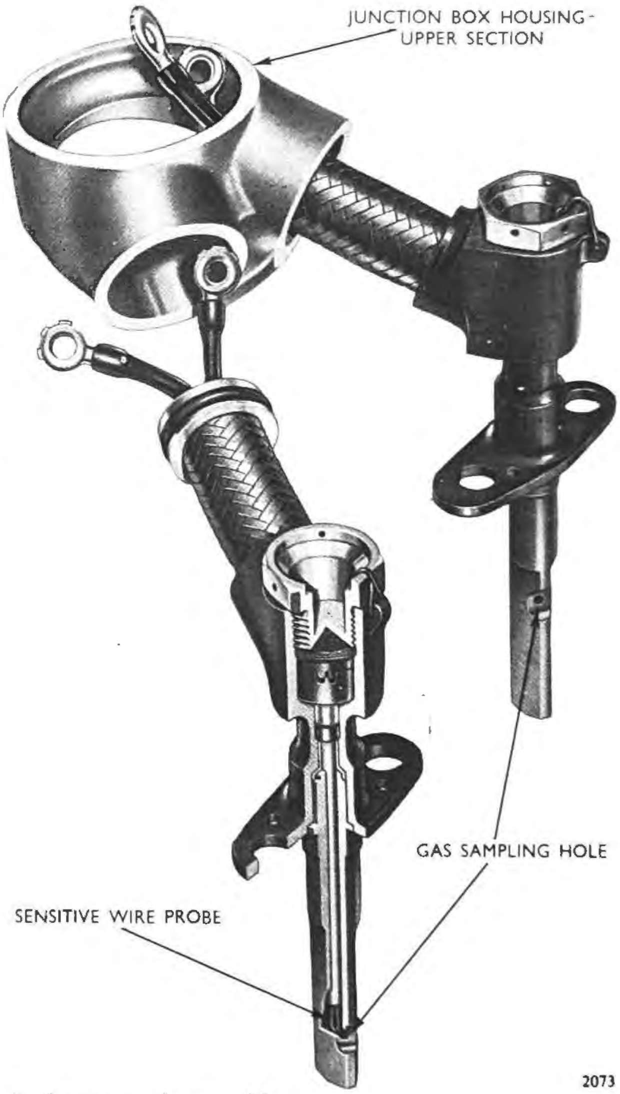


Fig. 2 Twin thermocouple assembly

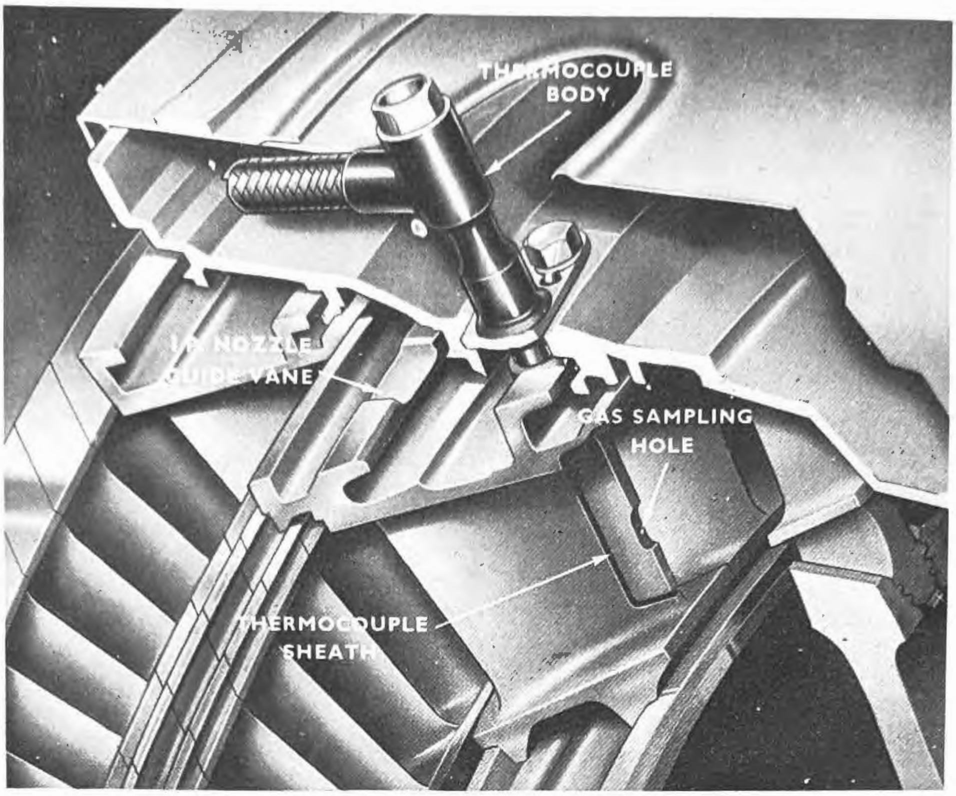


Fig. 3 Thermocouple in intermediate nozzle guide vane

Each thermocouple consists of a sensitive wire probe encased by a sheath of heat-resisting steel shaped to form part of an aerofoil. When positioned in the turbine, each thermocouple locates in a nozzle guide vane, which is recessed to accommodate it. The sheath forms the leading edge of the aerofoil shaped guide vane.

Two types of thermocouple, long reach and short reach, are used in the assembly. The wire probe of the long reach type senses, through sampling holes in the sheath, the temperature of gases passing over the inner portion of the n.g.v. leading edge. The shorter probe of the short reach type senses gas flow temperature through sampling holes in the outer portion of the n.g.v. leading edge.

The thermocouples are arranged around the nozzle box in pairs; each pair consists of one long and one short reach thermocouple which are connected by flexible armoured cable to a junction box.

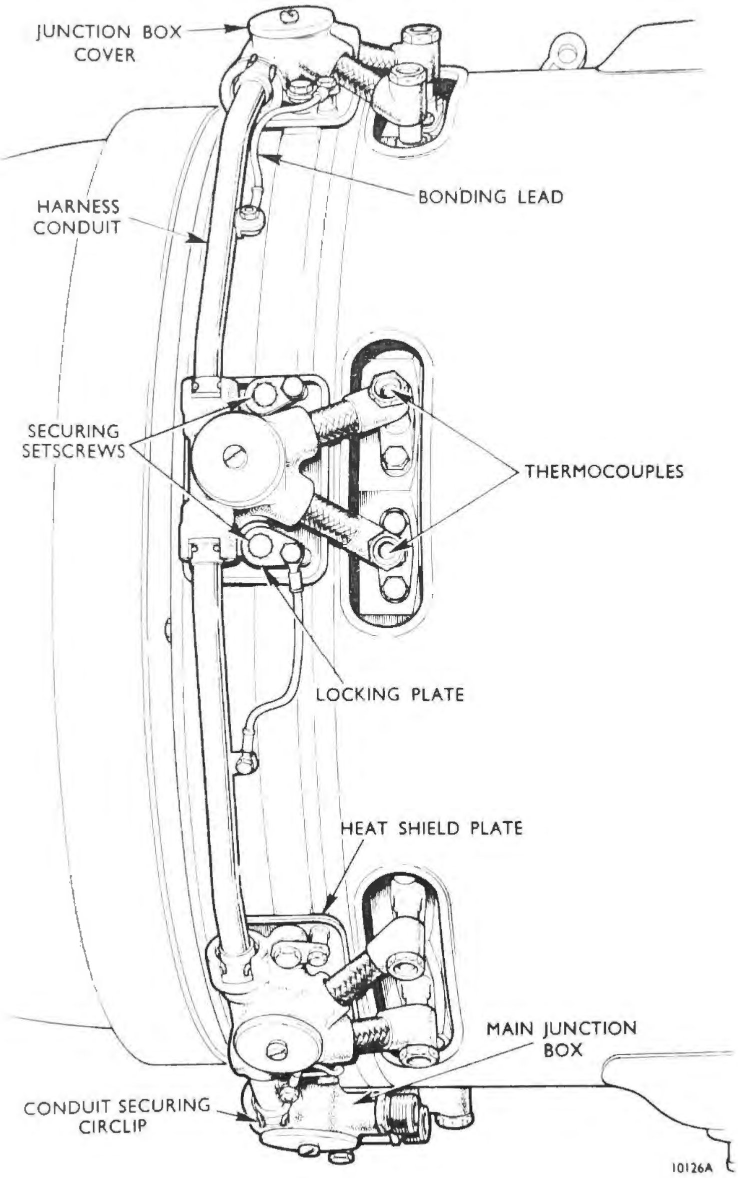
Six junction boxes, interconnected by an aluminium conduit carrying the wiring, are arranged around the nozzle box heat shield and each box serves one pair of thermocouples.

THERMOCOUPLES AND HARNESS - MAINTENANCE PRACTICES

1. Removal/Installation

A. Remove the harness assembly

(1) Remove the screw, double-coiled spring washer and plain washer securing each intermediate junction box cover, and remove the covers.



Thermocouple harness
Fig.201

MMcP8 Bmr M-I A,B,D,F,G,H, 222,650 & H Printed in Gt.Britain

(2) Remove the setscrews, double-coiled spring washers and plain washers and disconnect the thermocouple leads from the terminal block in each junction box.

NOTE: The setscrews may be temporarily replaced in the terminal block to prevent loss, but they must not be fully screwed down or tightened as this may damage the terminal block.

(3) Unlock the tabwashers, then remove the setscrews which secure each thermocouple to the nozzle box; remove the thermocouples, complete with the upper section of each junction box housing, from the engine.

(4) Withdraw each thermocouple assembly from the upper section of its junction box housing; remove and discard the rubber sealing ring from the thermocouple flanged tube.

(5) If the engine is not installed in the aircraft, proceed as follows:

(a) Release the lock washers from the setscrews which secure each intermediate junction box to the nozzle box heat shield. In turn, remove the setscrews, double-coiled spring washers and plain washers which secure each junction box and remove the loose assembly of heat-insulating washers and plates.

(b) Remove the setscrews, spring washers and plain washers which secure the main junction box to the heat shield and remove the loose assembly of heat-insulating washers and plates from the engine; remove the harness assembly from the engine.

(6) If the engine is installed in the aircraft, it may be necessary to split the harness into halves to facilitate removal; proceed as follows:

(a) Disconnect the fuel drain pipe and the harness extension lead coupling nut connection from the main junction box.

(b) Remove the circlip which retains the harness conduit at one side of the main junction box, then remove the main junction box cover.

(i) On engines embodying Mod.1567 (S.B.Da77-8) remove the 2 extended setscrew nuts, double-coiled spring washers and plain washers to release the harness extension lead terminals, then remove the 2 extended setscrews, double-coiled spring washers, plain washers and the trimmer (Fig.201A) to release the harness leads terminals and separate the halves.

(ii) On engines to pre-Mod.1567 standard remove the 2 setscrews, double-coiled spring washers and plain washers to release the harness extension lead and harness leads terminals and separate the halves.

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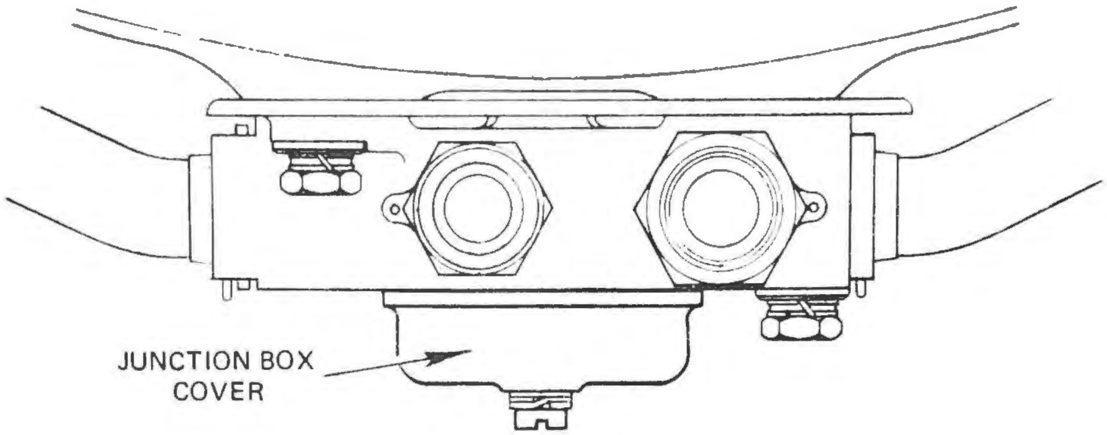
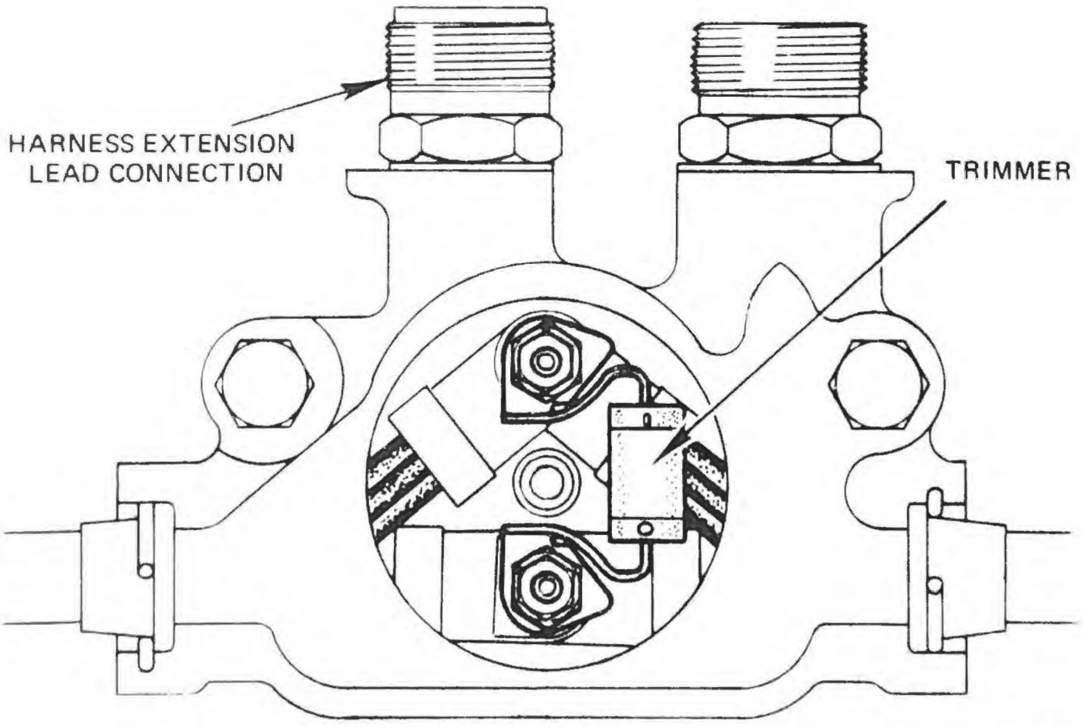
Thermocouples and harness - Maintenance practices (cont.)

(c) Dependent upon which conduit was disconnected at the main junction box, release the lock washers and, in turn, remove the setscrews, double-coiled spring washers and plain washers which secure each intermediate junction box of this harness section to the heat shield; remove the loose assemblies of heat-insulating washers and plates and withdraw the harness section from the engine.

(d) Remove the setscrews, spring washers and chamfered washers which secure the main junction box to the heat shield; remove the heat-insulating washers and plates.



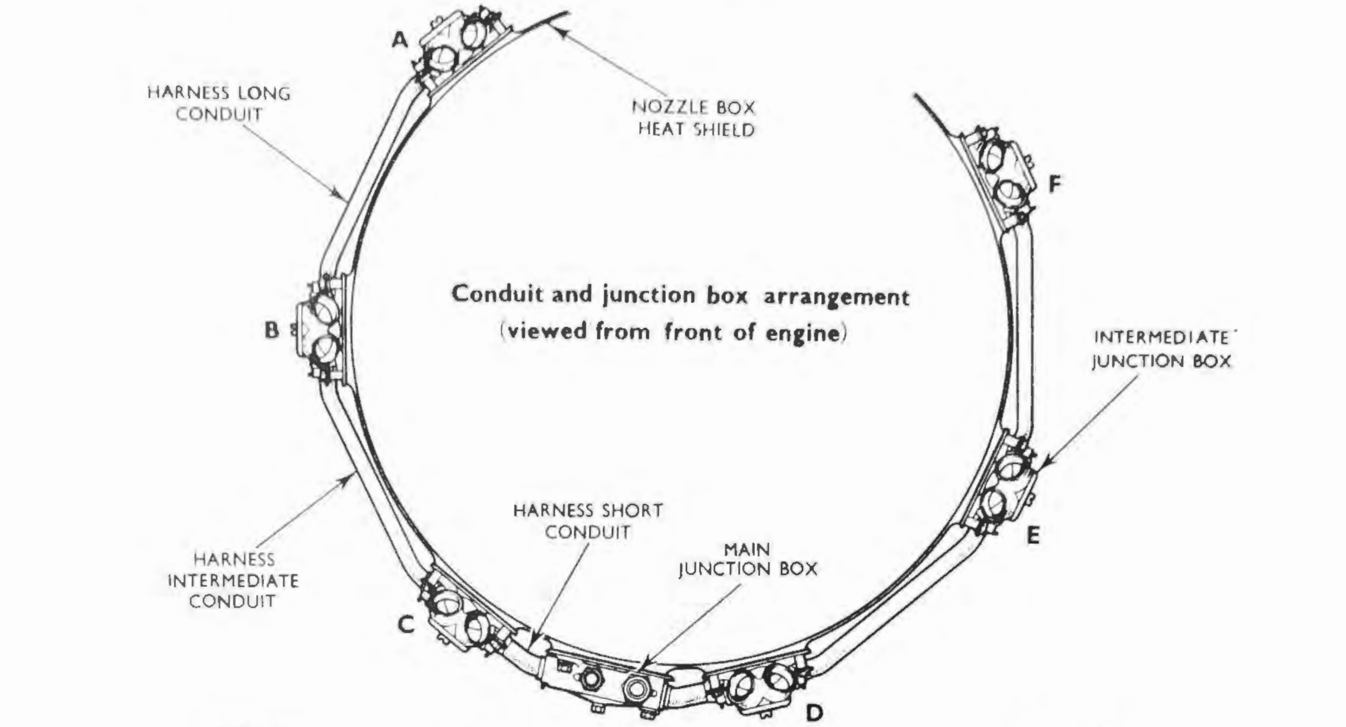
External view



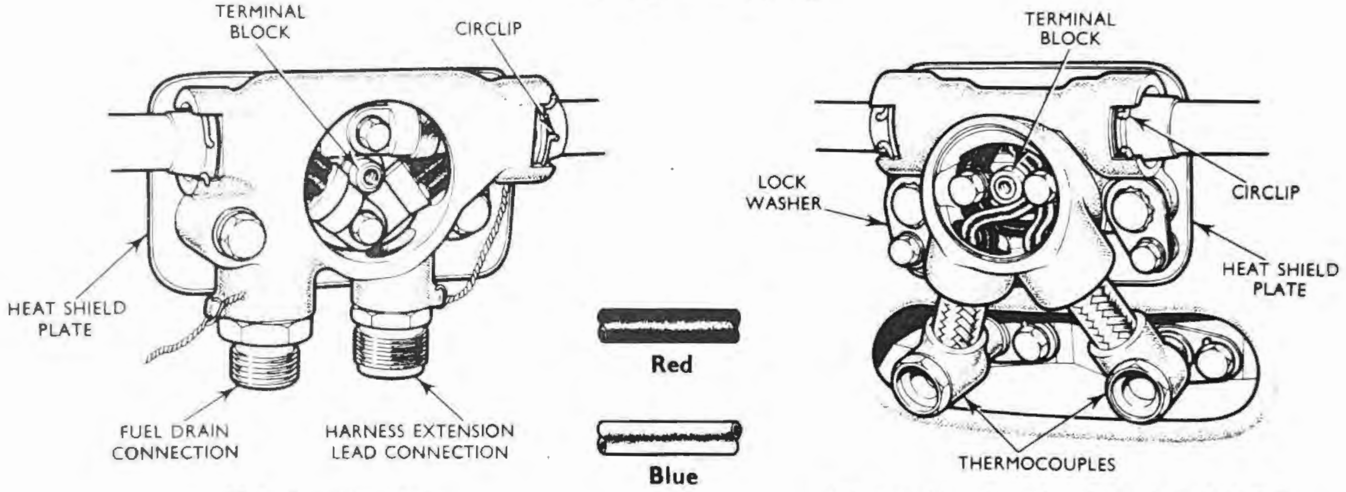
Internal view

Main junction box (Mod.1567)
Fig.201A

Thermocouples and harness - Maintenance practices (cont.)

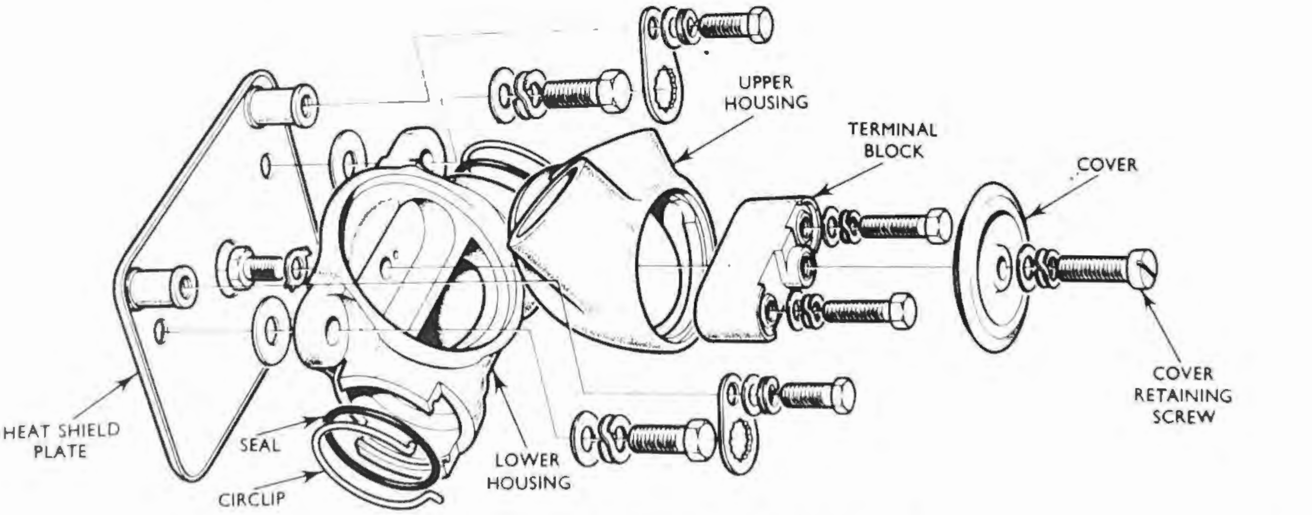


Conduit and junction box arrangement (viewed from front of engine)



Main junction box

Intermediate junction box A,B,C,D,E,F.



Exploded view of intermediate junction box

Conduits and junction boxes
Fig.202

(e) Release the lock washers and, in turn, remove the setscrews, double-coiled spring washers and plain washers which secure each intermediate junction box of the remaining harness section to the heat shield; remove the loose assemblies of heat-insulating washers and plates Remove the harness section, complete with main junction box, from the engine.

B. Install the harness assembly

(1) If the original harness is being refitted, renew all the heat-insulating fibre washers and any rubber sealing rings which were disturbed. If a new harness assembly is being fitted, remove the junction box covers and the thermocouples/upper housing assemblies to facilitate installation.

NOTE: To facilitate replacement the harness may be split into halves, see 1.A.(6).

(2) Position a heat shield plate between the main junction box and its locating bosses on the nozzle box, interpose a heat-insulating washer between the plate and the junction box and each mounting hole, then secure the junction box assembly to the nozzle box, using the appropriate chamfered washers, spring washers and setscrews.

(3) Position a heat shield plate, distance pieces facing outwards, between each intermediate junction box and its locating bosses on the nozzle box, interpose a heat-insulating washer between the plate and the junction box at each mounting hole, then secure each junction box assembly to the nozzle box, using the appropriate plain washers, double-coiled spring washers and setscrews. Fully tighten the setscrews, slacken them back approximately one half-turn, then fit and secure the lock plates over the setscrews.

(4) Fit the thermocouples, complete with the upper section of each junction box housing, as follows:

(a) Insert each pair of thermocouples in the appropriate apertures in the heat shield, and position them in their nozzle box locations.

NOTE: The thermocouples are of two types i.e., long-reach and short-reach. The correct type for a given aperture will be apparent from the disposition of the holes in the thermocouple flange and those in the nozzle box location. The thermocouple wiring diagram (Fig.203) shows the relative positions of the thermocouples.

(b) Secure each thermocouple in the nozzle box, using the appropriate tabwashers and setscrews; tighten the setscrews to the torque load specified in Chapter 89 and bend up the locking tabs.

(5) Connect the thermocouple leads to the harness leads (Fig.204) within each intermediate junction box as follows:

(a) Select the two thermocouple leads with blue insulation and the main harness lead with blue insulation; with the main harness terminal uppermost, align the eyes of the three terminals and secure the terminals to the right-hand side of the junction box terminal block, using the appropriate plain washers, double-coiled spring washers and setscrews.

(b) Align the three red insulation terminals over the left-hand side of the terminal block, the thermocouple terminals uppermost, then secure the terminals to the terminal block, using the appropriate plain washers, double-coiled spring washers and setscrews.

(6) Fit the junction box covers and secure with the appropriate plain washers, double-coiled spring washers and screws.

C. Remove individual thermocouple

(1) Unscrew the central screw which secures the cover on the appropriate intermediate junction box; remove the screw, double-coiled spring washer and plain washer, and the cover.

(2) Remove the setscrews, double-coiled spring washers and plain washers to disconnect the thermocouple leads from the terminal block in the junction box.

(3) Remove the setscrews and tabwashers which secure the pair of thermocouples in the nozzle box; remove the thermocouples, complete with the upper section of each junction box housing, from the engine.

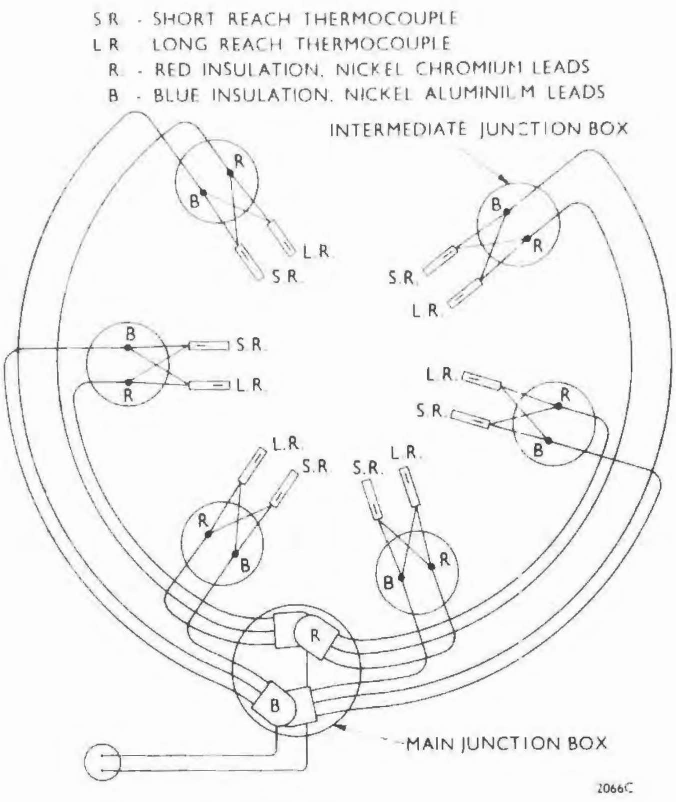
(4) Withdraw the affected thermocouple from the upper section of its junction box housing; remove and discard the rubber sealing ring from the thermocouple flanged tube.

D. Install individual thermocouple

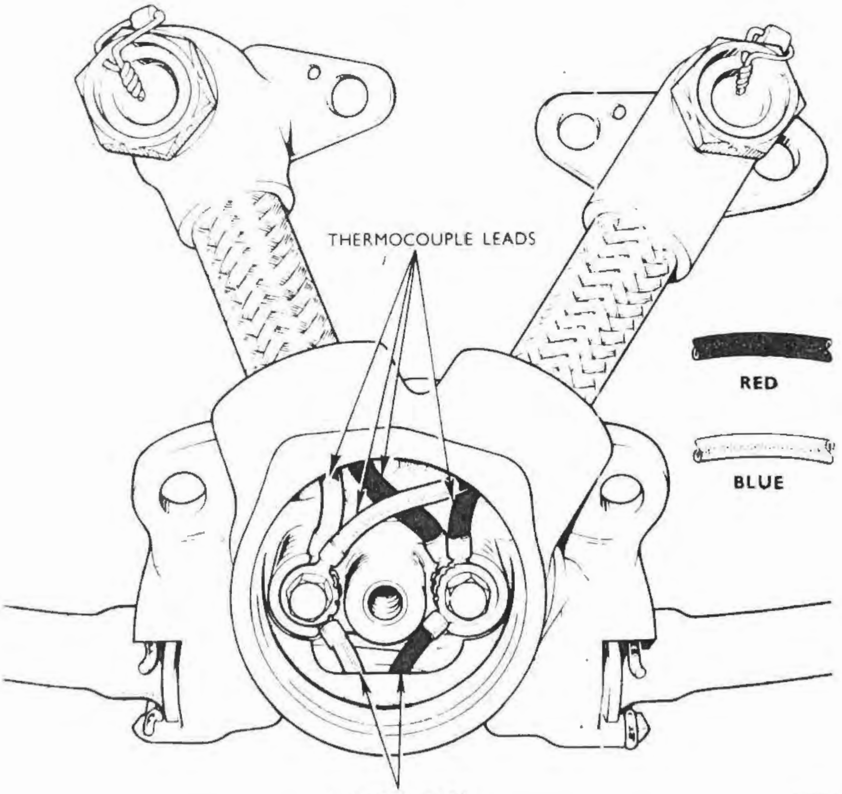
(1) If the original thermocouple is being replaced, fit a new rubber sealing ring to the flanged tube.

(2) Insert the thermocouple leads through the appropriate bore in the upper section of the junction box housing, and push the thermocouple conduit fully home.

(3) Proceed as described in para.B.(4) to (6).


S.R. - SHORT REACH THERMOCOUPLE
L.R. - LONG REACH THERMOCOUPLE
R. - RED INSULATION, NICKEL CHROMIUM LEADS
B. - BLUE INSULATION, NICKEL ALUMINIUM LEADS
INTERMEDIATE JUNCTION BOX
R
B
L.R.
S.R.
MAIN JUNCTION BOX
2066C

Thermocouple wiring diagram (viewed from front of engine)
Fig.203



Intermediate junction box - thermocouple wiring details
Fig.204

2. Adjustment/Test

A. Function test turbine gas temperature (T.G.T.) indicating system

(1) Whenever a thermocouple, thermocouple harness or part of the thermocouple harness has been disconnected or renewed, circuit insulation and resistance tests must be made before ground running the engine to check the pyrometry system. Run the engine and check that the indicated T.G.T. is consistent with engine conditions throughout the operating range.

B. Test engine thermocouples and harness

(1) If a defect is suspected in the pyrometry system, test the turbine gas temperature indicator and associated aircraft equipment before checking the serviceability of the complete thermocouple harness assembly.

NOTE: Fitment of Mod.1567 (S.B.Da77-8) trimmer resistor makes only minimal difference to the thermocouple harness resistance, therefore the specified values and tolerances remain unaltered.

(2) If tests are being made to investigate low turbine gas temperature on engines fitted with pre-Mod.1154 (S.B.Da77-4) thermocouples, remove each thermocouple from the nozzle box (para.1.C.) and check that the thermocouple probe is still visible through the gas sampling holes. If the probe is partly shrouded by a detached insulating sleeve, or if either of the sampling holes are blocked, renew the thermocouple.

(3) Recommended test equipment:

(a) 15 volt insulation resistance tester AVO 8, R.R. No. ERE.1147.

(b) Cambridge Decade Wheatstone Bridge.

(c) Master potentiometer, Foster type 3154D/1883, 3155/DP, 3156/DP or R.R. type GZ.38989 with one range 0-1400 degrees C. 0-60 mV calibrated for nickel-chromium and nickel-aluminium EMF/temperature constants.

(d) Rolls-Royce Resistance Box ID.493 (5, 8 and 25 ohms fixed resistance) complete with terminals.

(e) Low resistance instrument leads, total resistance not to exceed 0.020 ohms.

(f) Mercury thermometer with scale reading minus 40 degrees C. to plus 40 degrees C.

(4) Test thermocouple system insulation resistance with an AVO 8, R.R. No. ERE.1147.

(a) Remove the screw, double-coiled spring washer and plain washer, which secures the main junction box cover; remove the cover.

Thermocouples and harness - Maintenance practices (cont.)

(i) On engines embodying Mod.1567 (S.B.Da77-8) remove the 2 extended setscrew nuts, double-coiled spring washers and plain washers to disconnect the harness extension lead terminals from the terminal block.

(ii) On engines to pre-Mod.1567 standard remove the setscrews, double-coiled spring washers and plain washers to disconnect the harness extension lead terminals from the terminal block. Replace the setscrews and washers to secure the thermocouple harness terminals as shown in Fig.205.

NOTE: Before proceeding with the test, the AVO scale should be set to zero as follows: Set 'AC & Ω RANGES' selector to x 100 ohms. Short out both leads by touching the lead ends together then zero the scale by adjustment of the 'ZERO Ω x 100' knob.

(b) Connect one lead of the AVO to either of the terminals in the main junction box.

(c) Connect the other lead of the AVO to 'earth' by attaching it to a retaining setscrew on the main junction box.

(d) Check that the insulation resistance is not less than 10,000 ohms.

(e) If the insulation resistance is satisfactory, remove the AVO and connect the harness extension lead terminals to those in the main junction box; fit and secure the junction box cover.

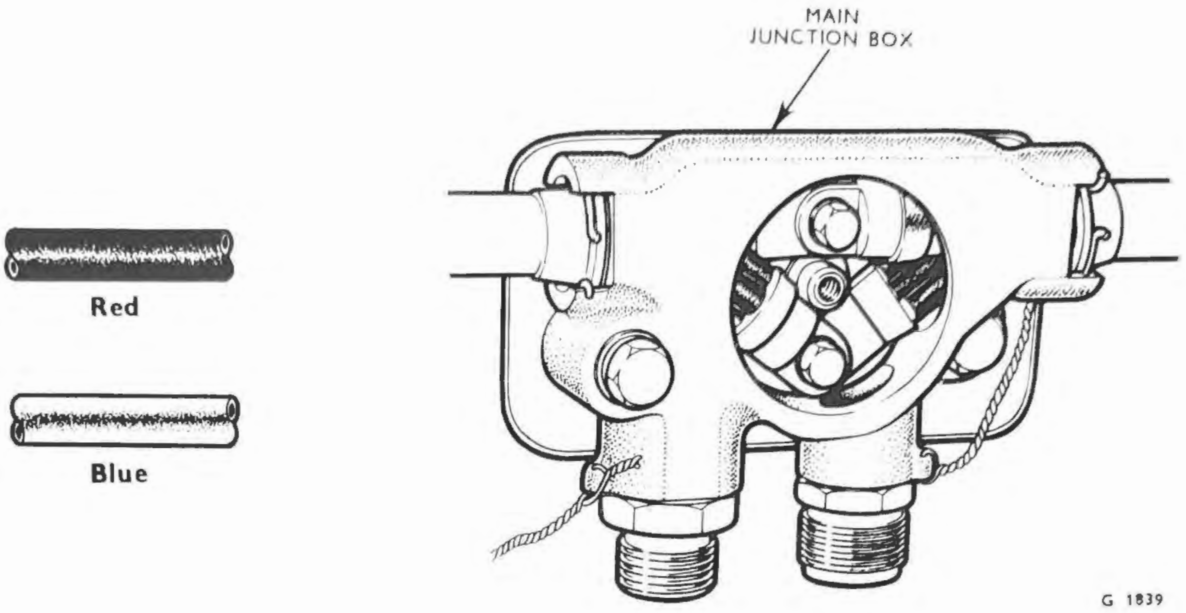
(f) If the insulation resistance is unsatisfactory, proceed as follows:

(i) Remove the 2 setscrews, double-coiled spring washers, plain washers and trimmer, if fitted, then disconnect all the left-hand conduit leads from the terminals in the main junction box. Replace the setscrews and washers to secure the right-hand conduit leads to the terminal block.

(ii) Connect one lead of the AVO to either of the terminals in the main junction box, and the other lead to a retaining setscrew on the main junction box.

(iii) Check that the insulation resistance of the right-hand thermocouple and harness assembly is not less than 10,000 ohms.

(iv) If the insulation resistance is unsatisfactory, remove the cover of each intermediate junction box in the right-hand assembly and, in turn, disconnect the thermocouple leads and check that each individual thermocouple/leads assembly has an insulation resistance value not less than 100,000 ohms. Renew any thermocouple assembly which registers a lower value.



Main junction box - wiring details (pre-Mod.1567)
Fig.205

(v) If, however, the thermocouple insulation resistance is satisfactory, renew the appropriate conduit assembly.

(vi) Repeat (i) to (v) for the left-hand thermocouple and harness assembly, if required.

(vii) Finally, connect both sets of conduit leads, trimmer if fitted, and the harness extension leads to the terminal block and secure them with the plain washers, double-coiled spring washers, setscrews and, if required, nuts.

(viii) Fit the covers to the junction boxes and secure with the appropriate plain washers, double-coiled spring washers and screws.

(5) Test thermocouple system circuit resistance (with Wheatstone Bridge) Fig.206.

NOTE: The engine must be cool before circuit resistance checks are made. The following resistance values were evaluated at an ambient temperature between plus 18 degrees C. and 22 degrees C.

(a) Remove the screw, double-coiled spring washers and plain washers which secures the main junction box cover; remove the cover.

(b) Remove the harness extension lead terminals from the terminal block as instructed in para.B.(4) (a) (i) or (ii), as appropriate.

(c) On engines embodying Mod.1567 (S.B.Da77-8) remove the trimmer, as instructed in 1.'Removal/Installation', then connect the test leads to the trimmer terminals and to Wheatstone Bridge terminals X1 and X2.

  (i) Set ratio switch A to X.001.

  (ii) Adjust controllers C,D,E and F to the equivalent value of 4.678 ohms (10 degrees C. trimmer) or 2.339 ohms (20 degrees C. trimmer), as appropriate, plus the known resistance value of the test leads, and check by the method detailed in para.(e), (f),(j) and (k) that the trimmer resistance value is 4.678 ± 0.094 ohms or 2.339 ± 0.047 ohms, after deduction of test leads resistance value.

  (iii) If the trimmer resistance check is satisfactory, refit the trimmer and continue with the harness circuit resistance check (para.(d)).

  (iv) If the trimmer resistance check is unsatisfactory, reject the trimmer and fit a serviceable replacement trimmer, then continue with the harness circuit resistance check (para.(d)).

(d) Connect the test leads to Wheatstone Bridge terminals X1 and X2, and to the terminals of the main junction box.

(e) Release the galvanometer clamp by selecting the FREE position on the switch.

(f) Operate the zero adjuster screw until the galvanometer registers zero on the dial.

(g) Set ratio switch A to X.001 (X.01 where applicable).

(h) Adjust controllers C,D,E and F to the equivalent of 0.065 ohms plus the known resistance value of the test leads.

(j) Depress and rotate key B in a clockwise direction to 'lock-in'.

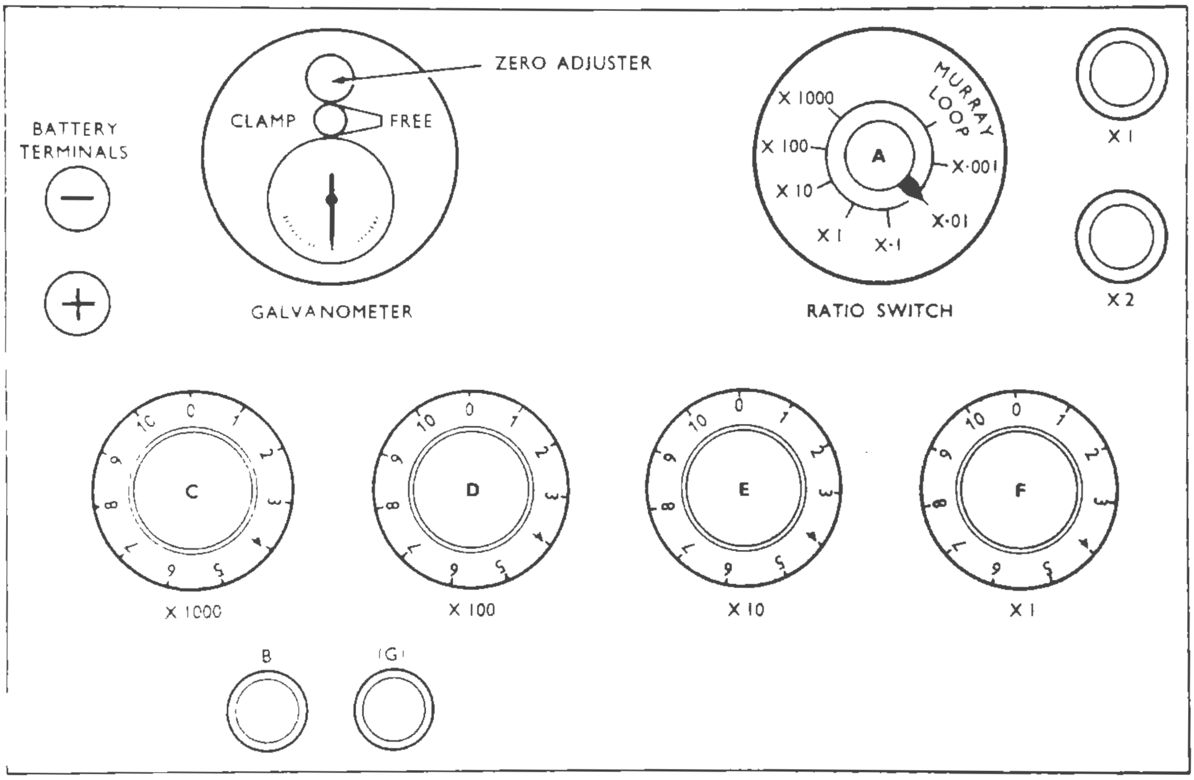
(k) Press and release key G and observe the galvanometer pointer deflection. Continue adjusting controllers C,D,E and F until no deflection is observed.

(m) Check that the thermocouple and harness circuit resistance, after deduction of test leads resistance, is 0.065 ± 0.005 ohms.

(6) Measure local circuit resistance at intermediate junction box.

(a) Remove the covers and clip the test leads to each pair of thermocouples and successively connect to each of the intermediate junction boxes. The circuit resistance values recorded should be as follows:

(i) Fully serviceable harness (all twelve thermocouples satisfactory) 0.083 ± 0.008 ohms per thermocouple pair at each junction box.



Wheatstone Bridge (controls arrangement)
Fig.206

(ii) One open circuited thermocouple (at any intermediate junction box) 0.135 ± 0.015 ohms. Remaining junction boxes with intact thermocouples 0.083 ± 0.008 ohms per thermocouple pair at each junction box.

(iii) Two open circuited thermocouples (at any intermediate junction box) 0.355 ± 0.025 ohms. Remaining junction boxes with intact thermocouples 0.083 ± 0.008 ohms per thermocouple pair at each junction box.

(b) If the circuit resistance is incorrect and the preceding checks prove unsatisfactory, further checks may be carried out with the harness installed assuming that accessibility is possible. The procedure is as follows:

(i) Disconnect all thermocouple leads from the intermediate junction box terminals and close each junction box circuit in turn by short circuiting the terminals with a copper strip of negligible resistance. Ensure that the terminals of each junction box except the one under test remain open circuited. Check that the resistance value of the leads of each junction box circuit is 0.275 ± 0.015 ohms. Replace any defective cable loom.

(ii) Remove the thermocouples and connect each individually by its terminals to the Wheatstone Bridge leads.

(iii) Set the ratio switch (A) to X.001 (X.01 where applicable).

(iv) Adjust the controllers C,D,E and F to give the value in (v) and operate the Wheatstone Bridge as described in para. B.(5).

(v) Check the resistance of each thermocouple in the defective circuits, the value recorded should be 0.226 ± 0.022 ohms for long reach couples, and 0.212 ± 0.021 ohms for short reach couples.

(vi) If any thermocouple resistance is slightly higher than the specified value, remove the Ross Courtney terminals and clean the wires, fit new terminals and recheck the circuit resistance value.

(vii) When all thermocouples have been tested and replaced in the harness, recheck the overall resistance value of the complete harness and ascertain that it is within the specified limits.

NOTE: The resistance of the aircraft lead from the main junction box to the engine bulkhead is a component of the total harness-to-instrument resistance. This will be related to the type of instrument fitted which can be either 8.0 or 25.0 ohms. When it is necessary to check this aircraft lead because of renewal or repair the procedure should be as follows in para.C.

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C. Test circuit resistance of thermocouple harness extension lead

(1) Disconnect the harness extension lead at the aircraft bulkhead and the lead connection at the main junction box, as instructed in 1.'Removal/ Installation', and clamp together the two leads at the junction box end.

(2) Connect a pair of copper leads of known resistance not in excess of 0.020 ohms to the plug connection on the harness extension at the aircraft bulkhead end, and secure the opposite end of the copper leads to the Wheatstone Bridge terminals. The total resistance of the harness leads is the bridge reading minus the resistance of the copper leads.

(3) Check by the method detailed in para.B.(5) (e) to (k) that the extension lead circuit resistance, after deduction of test leads resistance, is satisfactory. The circuit resistance values for harness extension leads supplied by Rolls-Royce are as follows:

Engine Mk. No.	Circuit resistance value
528) 532)	0.350 ± 0.018 ohms
529	0.272 ± 0.015 ohms

D. Test aircraft turbine gas temperature indicating circuit

(1) Test the aircraft indicating circuit resistance (with Wheatstone Bridge) Fig.206.

NOTE: The aircraft circuit resistance includes the compensating leads, variable resistor, harness extension leads, thermocouples and harness and, if fitted, trimmer; the trimmer resistance value must be within the limits specified in para.B.(5) (c) (ii).

(a) Gain access to the turbine gas temperature indicator.

(b) Disconnect the compensating leads from the turbine gas temperature indicator.

(c) Connect the test leads (para.B.(3)(e)) to Wheatstone Bridge terminals X1 and X2 and to the compensating leads.

(d) Adjust controllers C,D,E and F to the equivalent value of 8.0 (or 25.0) ohms and check by the method detailed in para.B.(5)(e) to (k) that the aircraft circuit resistance is 8.0 ± 0.10 (or 25.0 ± 0.15) ohms after deduction of test leads resistance.

(e) If the aircraft circuit resistance is more than 8.1 ohms (or 25.15 ohms) adjust the variable resistor, provided that the thermocouples, harness and extension lead have been individually checked as described in para.2.A.B. and C.

(f) If the aircraft circuit resistance is less than 7.9 ohms (or 24.85 ohms) fit a new variable resistor, provided that the thermocouples, harness and extension lead have been individually checked as described in para.2.A.B. and C. Adjust the resistor to obtain the correct value.

(g) When the aircraft circuit resistance is satisfactory, proceed as follows:

(i) Disconnect the Wheatstone Bridge test leads from the compensating leads.

(ii) Connect the compensating leads to the appropriate terminals of the turbine gas temperature indicator.

E. Test T.G.T. indicator

(1) Test equipment

(a) Master potentiometer, Foster type 3154D/1883, 3155/DP, 3156/DP or R.R. type GZ.38989 with one range 0-1400 degrees C. 0-60 mV calibrated for nickel-chromium and nickel-aluminium EMF/temperature constants.

(b) Rolls-Royce Resistance Box ID.493 (5, 8 and 25 ohms fixed resistances) complete with terminals.

(c) Mercury thermometer with scale reading minus 40 degrees C. to plus 40 degrees C.

(d) Low resistance instrument leads with total resistance not exceeding 0.020 ohms.

(2) Standardize Foster potentiometer before use, types 3154D/1883, 3155DP and 3156DP.

(a) Ensure that buttons K1 and K3 are unlocked.

(b) Ensure that the range plug is firmly plugged into the socket marked 60.

(c) Ensure that the galvanometer pointer is correctly aligned with the zero mark on the scale. If necessary, use the zero screw on the galvanometer.

(d) Depress button K1 and release quickly noting any deflection of the galvanometer pointer. If deflection occurs, turn the standardizing rheostat knob slowly. Continue to press and release button K1 until there is no deflection.

Thermocouples and harness - Maintenance practices (cont.)

(e) To ensure accurate readings repeat (a) to (d) periodically while the potentiometer is in use.

(3) Test/calibrate T.G.T. indicator before installation in aircraft with Foster potentiometer, type 3154D/1883.

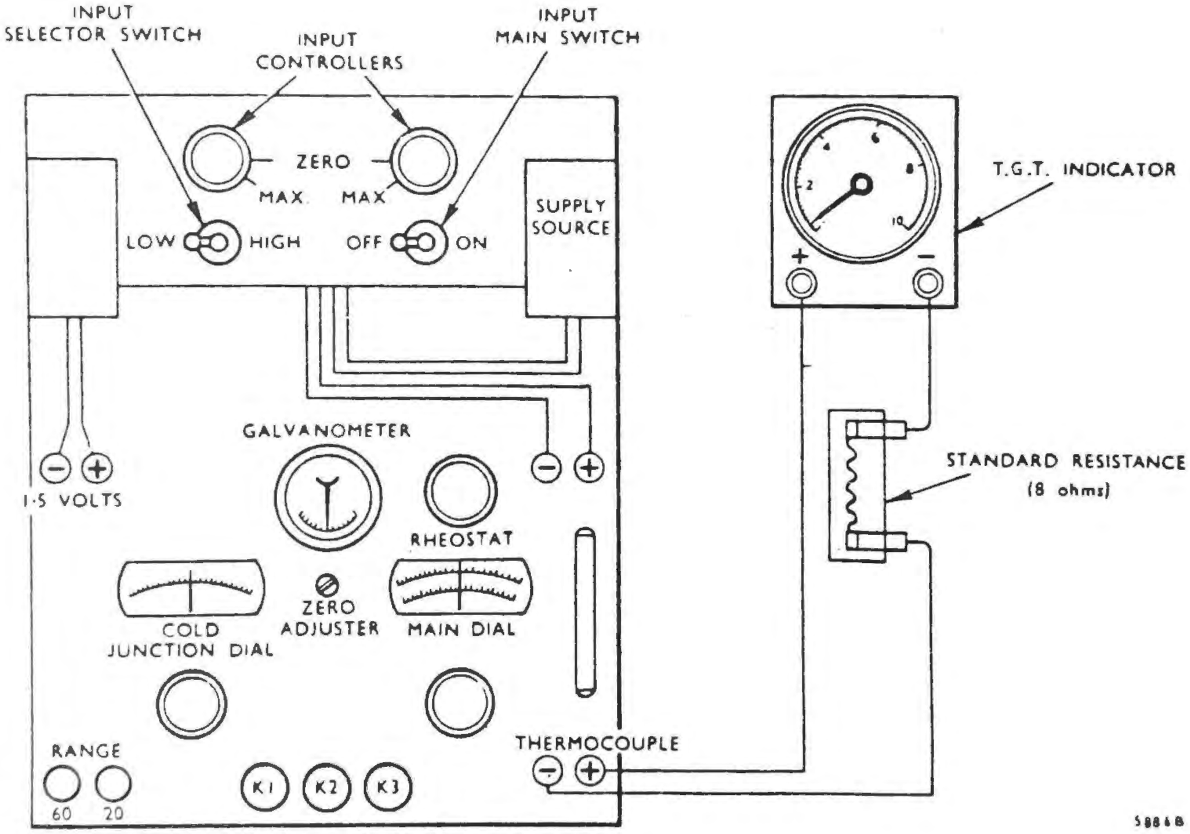
(a) Test T.G.T. indicator.

(i) Standardize potentiometer before use, refer to para.E.(2).

(ii) Ensure that the indicator is the correct type for the installation, 5, 8 or 25 ohms. The external resistance value of the indicator is marked on the dial or external data plate, and should be the same value as the aircraft thermocouple harness

(iii) Place a mercury thermometer adjacent to the indicator. Protect indicator and thermometer from draught and direct sunlight. Allow at least 15 minutes to elapse, enabling the thermometer reading to stabilize, and note the temperature reading of the thermometer.

(iv) Ensure that the potentiometer, indicator, test circuit and connections are at the same ambient temperature.



Foster potentiometer (controls and wiring arrangement)
Type 3154D/1883
Fig.207

(v) Connect the T.G.T. indicator to the potentiometer with the recommended low resistance leads. Include an 8 (or 25) ohms series resistance in the negative line of the test circuit. Ensure correct polarity of all connections.

(vi) Ensure that the potentiometer supply is connected correctly to the polarity terminals on the potentiometer panel.

(vii) Select input selector switch to LOW and zero input controllers.

(viii) Set cold junction dial to zero.

(ix) Set main dial to 100 degrees C. on the nickel-chromium, nickel-aluminium scale.

(x) Select input main switch ON.

(xi) Press and release K2 contact button and turn the input control knob until the circuit is balanced at 100 degrees C. on the nickel-chromium, nickel-aluminium scale, i.e. no galvanometer deflection and check that the T.G.T. indicator pointer registers 100 degrees C ± 30 degrees C.

NOTE: If input required for balancing is unobtainable return input controller to zero, select HIGH on selector switch and adjust inout controller as required.

(xii) Repeat (viii) to (x) at 100 degrees C. intervals on the indicator scale up to maximum indicated T.G.T.

(b) Calibrate T.G.T. indicator

NOTE: Calibration should be carried out at an ambient temperature of plus 20 degrees C. ± 5 degrees C.

(i) Connect T.G.T. indicator to potentiometer as instructed in para. E.(3).

(ii) Set potentiometer cold junction dial pointer to the temperature reading obtained in E.(3).

(iii) Select main input switch ON.

(iv) Set the main dial to 860 degrees C. on the nickel-chromium nickel-aluminium scale.

(v) Increase and adjust potentiometer supply with input controller until the circuit is balanced at 860 degrees C. on the main dial.

(vi) Check T.G.T. indicator reading and turn the adjusting screw on the face of the indicator to set the indicator pointer at 860 degrees C. When the pointer setting is correct turn the adjusting screw slightly in the opposite direction to relieve the compensating mechanism.

(vii) Recheck indicator setting of 860 degrees C.

(viii) Check the indicator as instructed through its effective range, i.e. at cardinal points above and below indicator 'set point' (refer to Aircraft Maintenance Manual) or at any point where T.G.T. is suspect.

Thermocouples and harness - Maintenance practices (cont.)

(ix) Turn the coarse and fine controls fully anti-clockwise and select the potential divider switch OFF.

(4) Test/calibrate T.G.T. indicator before installation in aircraft with Foster potentiometer types 3155/DP and 3156/DP.

(a) Test T.G.T. indicator

(i) Standardize potentiometer before use, refer para.E.(2).

(ii) Ensure that the indicator is the correct type specified for the installation 5, 8 or 25 ohms. The external resistance value of the indicator is marked on the dial or external data plate and should be the same value as the aircraft thermocouple harness.

(iii) Place a mercury thermometer adjacent to the indicator. Protect the indicator and thermometer from draught and direct sunlight. Allow at least 15 minutes to elapse, enabling the thermometer reading to stabilize and note the temperature reading of the thermometer.

(iv) Ensure that the potentiometer, indicator, test circuit and connections are at the same ambient temperature.

(v) Ensure that the potential divider switch is at OFF.

(vi) Connect the T.G.T. indicator to the potentiometer as instructed in para. E.(3).

(vii) Turn the coarse and fine controls fully anti-clockwise.

(viii) Select the potential divider switch to ON.

(ix) Set cold junction dial to zero.

(x) Set main dial to 100 degrees C. on the nickel-chromium nickel-aluminium scale.

(xi) Depress K2 button and turn clockwise to 'lock-in' then adjust the coarse and fine controls until the circuit is balanced at 100 degrees C. on the nickel-chromium, nickel-aluminium scale, i.e. no galvanometer deflection.

(xii) Depress K2 button, turn anti-clockwise then release.

(xiii) Check that the T.G.T. indicator pointer registers 100 degrees C. ±30 degrees C.

(xiv) Repeat (xi) to (xiii) at 100 degrees C. intervals on the indicator up to the maximum indicated T.G.T.

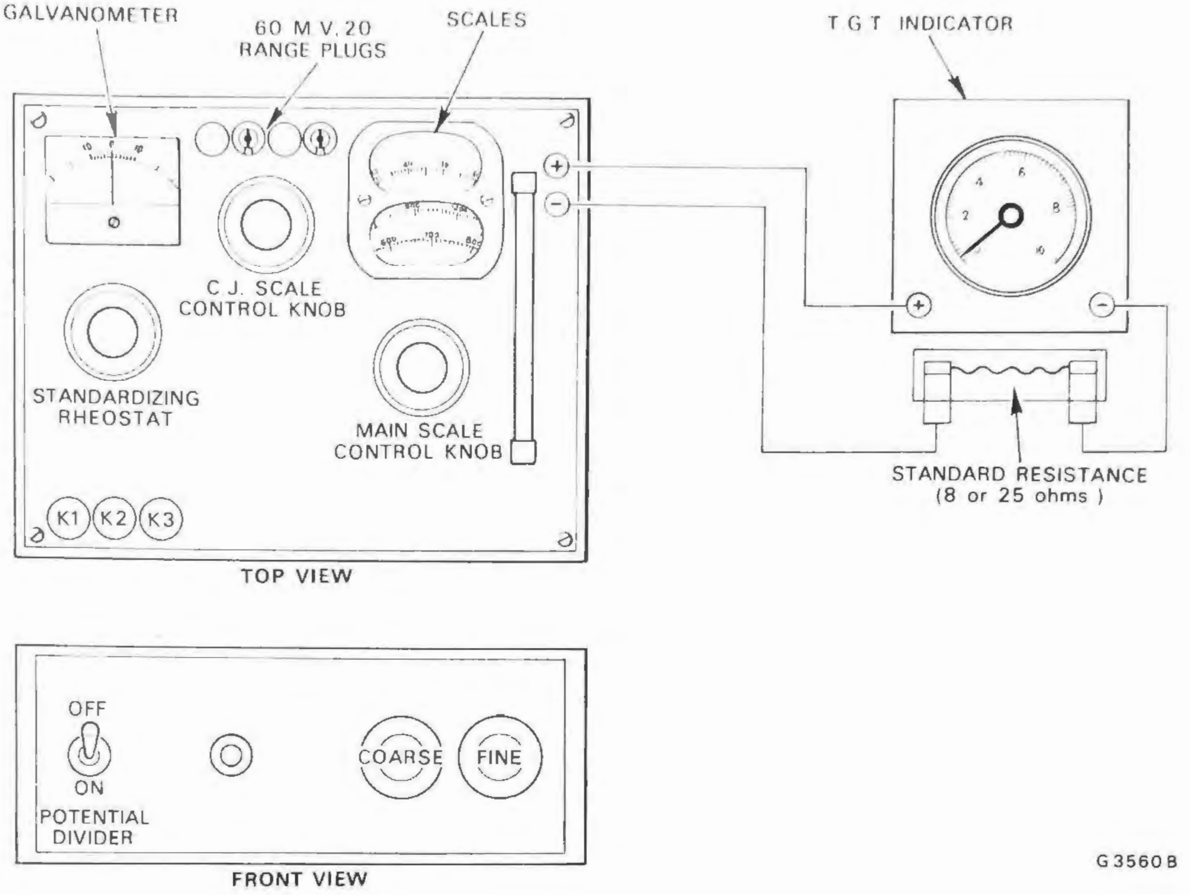
(xv) Select the potential divider switch OFF.

(b) Calibrate T.G.T. indicator

NOTE: Calibration should be carried out at an ambient temperature of + 20 degrees C. ± 5 degrees C.

(i) Standardize potentiometer before use, refer para.E.(2).

Thermocouples and harness - Maintenance practices (cont.)



Foster potentiometer (controls and wiring arrangement)
Type 3156 DP
Fig.208

(ii) Repeat actions described in para.(4), (ii) to (viii).

(iii) Set cold junction dial to thermometer temperature obtained at (4).

(iv) Set main dial to 860 degrees C. on the nickel-chromium nickel-aluminium scale.

(v) Depress K2 button and turn clockwise to 'lock-in' then adjust the coarse and fine controls until the circuit is balanced at 860 degrees C. on the nickel-chromium, nickel-aluminium scale, i.e. no galvanometer deflection.

(vi) Depress K2 button, turn anti-clockwise then release.

(vii) Check T.G.T. indicator reading and turn the adjusting screw on the face of the indicator to set the indicator pointer at 860 degrees C. When the pointer setting is correct turn the adjusting screw slightly in the opposite direction to relieve the compensating mechanism.

(viii) Recheck indicator setting of 860 degrees C.

(ix) Check the indicator through it's effective range, i.e. at cardinal points above and below indicator 'set point' (refer to Aircraft Maintenance Manual) or at any point where T.G.T. is suspect.

(x) Turn the coarse and fine controls fully anti-clockwise and select the potential divider switch OFF.

(5) Test/calibrate T.G.T. indicator installed in aircraft using Foster potentiometer types 3154/1883, 3155/DP and 3156/DP.

(a) Disconnect aircraft thermocouple compensating leads from the T.G.T. indicator terminals.

(b) Test and calibrate as instructed in relevant preceding paragraphs.

(6) Standardize potentiometer R.R. type GZ.38989 before use.

(a) The potentiometer may be standardized when the left rotary switch is selected to any position other than OFF.

(b) Ensure that the galvanometer pointer is correctly aligned with the zero mark on the scale using the zero screw on the galvanometer if necessary.

(c) Push the lever of the MEASURE - STANDARDIZE switch to STANDARDIZE and hold, adjust the standardizing rheostat until the galvanometer pointer indicates zero. When the MEASURE - STANDARDIZE switch is released there must not be any movement of the galvanometer pointer.

(d) To ensure accurate readings repeat (b) and (c) periodically when the potentiometer is in use.

(7) Test/calibrate T.G.T. indicator before installation in aircraft using potentiometer R.R. type GZ.38989.

(a) Test T.G.T. indicator

(i) Standardize potentiometer before use, refer to para.(6).

Thermocouples and harness - Maintenance practices (cont.)

(ii) Ensure that the indicator is the correct type specified for the installation 5, 8 or 25 ohms. The external resistance value of the indicator is marked on the dial or external data plate, and should be the same value as the aircraft thermocouple harness.

(iii) Place a mercury thermometer adjacent to the indicator. Protect the indicator and thermometer from draught and direct sunlight. Allow at least 15 minutes to elapse, enabling the thermometer reading to stabilize and note the temperature reading of the thermometer.

(iv) Ensure that the potentiometer, indicator, test circuit and connections are at the same ambient temperature.

(v) Select the right hand rotary switch OFF.

(vi) Connect the T.G.T. indicator to the potentiometer with the recommended low resistance leads as instructed in E.(3)(v) using number 2 terminal position.

(vii) Turn the coarse and fine controls fully anti-clockwise.

(viii) Select 60 m.V. on the range switch.

(ix) Select number 2 position on the rotary switch situated on left of the panel.

(x) Select the m.V. position on the rotary switch situated on the right of the panel.

(xi) Set cold junction dial to zero.

(xii) Set main dial to 100 degrees C. on the nickel-chromium, nickel-aluminium scale.

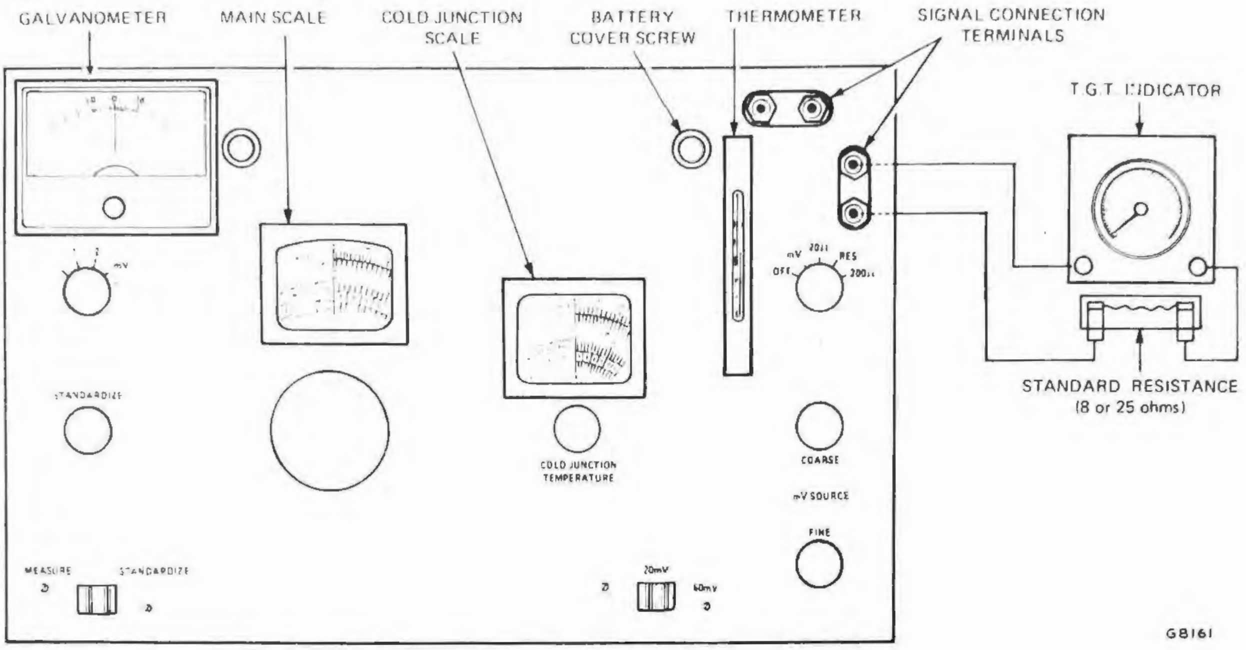
(xiii) Push the lever of the MEASURE - STANDARDIZE switch to MEASURE and hold, adjust the standardizing rheostat until the galvanometer pointer indicates zero. When the MEASURE - STANDARDIZE switch is released there must not be any movement of the galvanometer pointer.

(xiv) Check that the T.G.T. indicator pointer registers 100 degrees C. ± 30 degrees C.

(xv) Repeat (x) to (xii) at 100 degrees C. intervals on the indicator scale up to maximum indicated T.G.T.

(xvi) Set the temperature on the nickel-chromium, nickel-aluminium scale to that recorded at (iii) above by adjusting the cold junction temperature control knob.

Thermocouples and harness - Maintenance practices (cont.)



Potentiometer (controls and wiring arrangement)
(R.R. type GZ.38989)
Fig.209

(b) Calibrate T.G.T. indicator

NOTE: Calibration should be carried out at an ambient temperature of plus 20 degrees C. ± 5 degrees C.

(i) Standardize potentiometer before use, refer para.(5).

(ii) Set main scale to read 860 degrees C. on the nickel-chromium, nickel-aluminium scale.

(iii) Push the lever of the MEASURE - STANDARDIZE switch to MEASURE and hold, adjust the 'coarse' and 'fine' controls until the galvanometer reads zero then release the lever.

(iv) Check T.G.T. indicator reading and turn the indicator adjusting screw to set the pointer at 860 degrees C. When the pointer setting is correct, turn the adjusting screw slightly in the opposite direction to relieve the compensating mechanism.

(v) Recheck the indicator setting of 860 degrees C.

(vi) Check the indicator as instructed through its effective range, i.e. at cardinal points above and below indicator 'set point' (refer to Aircraft Maintenance Manual) or at any point where T.G.T. is suspect.

(vii) When checks are complete turn the coarse and fine controls fully anti-clockwise and both rotary switches to OFF.

(8) Test/calibrate T.G.T. indicator installed in aircraft using potentiometer R.R. type GZ.38989.

(a) Disconnect aircraft thermocouple compensating leads from the T.G.T. indicator terminals.

(b) Test and calibrate as instructed in relevant preceding paragraphs.

(9) Indicator acceptance tolerances.

As several types of T.G.T. indicators are in use, refer to the Aircraft Maintenance Manual for this information.

TORQUEMETER PRESSURE TRANSMITTER - MAINTENANCE PRACTICES

1. Servicing

A. Bleed the torquemeter oil pressure transmitter system.

(1) Remove the lock-wire and slacken the bleed union on the torquemeter pressure transmitter.

(2) Remove the lock-wire and disconnect the pressure oil pipe to the transmitter at the supply port on the water/methanol unit.

(3) Connect a force-feed oil can to the oil pressure pipe (a suitable adapter will be required between the pipe and can).

(4) Pump oil into the torquemeter pressure transmitter until an air free fluid flow issues from the bleed union.

NOTE: To ensure oil issues freely it may be necessary to 'joggle' the nipple on the bleed union.

(5) Maintain pressure with the oil can and tighten the bleed union.

(6) Remove the oil can and adapter; connect the oil pipe to the supply port on the water/methanol unit. Wirelock the oil pipe connection and the bleed union.

(7) On completion of the first ground run, check the oil pipe connections and the bleed union for leakage.

2. Removal/Installation

A. Remove the torquemeter pressure transmitter (fig.201).

CAUTION: ENSURE THAT THE ELECTRICAL SUPPLY TO THE TRANSMITTER IS OFF.

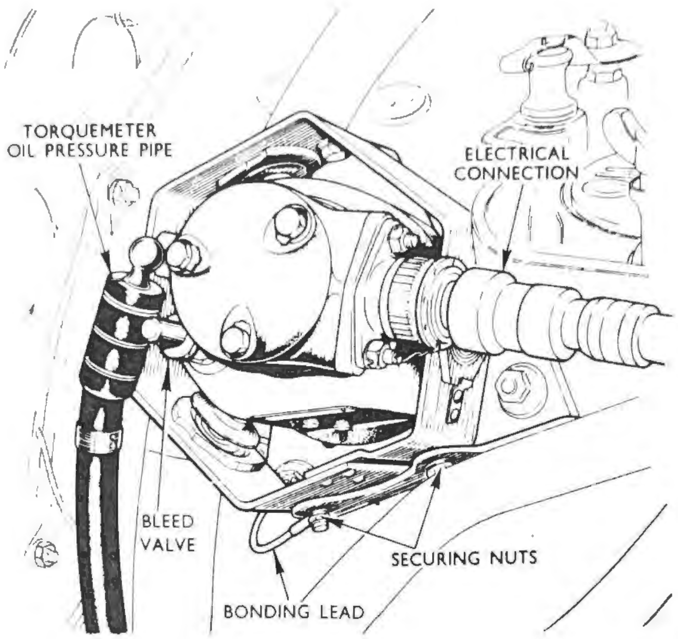
(1) Disconnect the electrical connection from the transmitter.

(2) Remove the lock-wire and disconnect the pressure oil pipe from its union on the transmitter.

(3) Withdraw the four split pins, nuts, washers and bolts which secure the transmitter anti-vibration bracket to its mounting bracket on the engine; note the location of the bonding lead.

(4) Remove the transmitter and bracket assembly.

Torquemeter pressure transmitter - Maintenance practices (cont.)



Torquemeter pressure transmitter removal details
Fig.201

B. Install the torquemeter pressure transmitter.

CAUTION: ENSURE THAT THE ELECTRICAL SUPPLY TO THE TRANSMITTER IS OFF.

(1) Fit the transmitter and anti-vibration bracket to its mounting bracket on the engine, replace the bolts, washers, bonding lead and nuts; tighten all nuts and lock them with split pins.

(2) Connect and wirelock the electrical connection.

(3) Connect the pressure oil pipe to its union on the transmitter, tighten and wirelock.

CAUTION: ENSURE THE PRESSURE OIL PIPE IS NOT KINKED OR TWISTED AND THE MOVEMENT OF THE TRANSMITTER ABOUT ITS MOUNTING SPRINGS IS UNRESTRICTED.

3. Adjustment/Test

A. Serviceability check

(1) Replenish the oil system (72-8).

(2) Check the torquemeter pressure during engine ground run (71-0, Adjustment/Test).

(3) Check the transmitter and pressure oil pipe line for leakage on completion of ground run.

4. Inspection/Check

A. Examine the transmitter and ensure that there are no oil leaks at the bleed point and the pressure oil pipe union.

B. Examine the electrical connection for security and ensure that it is free from oil contamination and corrosion.

C. Check the transmitter for security and the anti-vibration mounting for serviceability.

MAINTENANCE PRACTICES

OIL TEMPERATURE TRANSMITTER

REMOVAL

The temperature bulb assembly is situated adjacent to the port scavenge filter and is fitted with a plug attachment for the electrical connection. It may be removed without draining the oil tank if a replacement bulb and sleeve are prepared for immediate insertion on removal of the old unit.

Disconnect the electrical lead, unlock and remove the two nuts and bolts securing the flange of the assembly to its housing; using the tool HW.38076 withdraw the temperature bulb and sleeve. Cover the housing immediately to prevent oil loss.

Inspect the sealing ring on the sleeve for damage. If the ring is not intact proceed as follows.

Drain the oil from the tank; unscrew the five nuts, remove the temperature bulb housing and carefully clean the bore.

Using the jointing compound listed in 89-1 on the mating faces, refit the bulb housing and secure with five nuts, plain and Grover washers. Refill the engine tank with oil after fitting the new bulb unit.

REPLACEMENT

Fit a new sealing ring to the temperature bulb sleeve and smear it with clean engine oil. Press the assembly fully home into the housing, using the tool HW.38076 if necessary, and secure it with the two bolts, nuts and tabwashers.

Connect the electrical lead.

SERVICEABILITY CHECK

Carry out an engine serviceability run and check for leaks.

Inspect the pressure oil filter if the old temperature bulb sleeve sealing ring was not withdrawn intact.

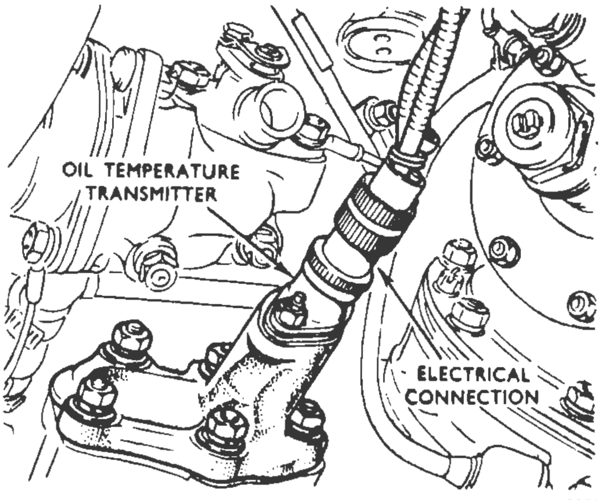


Fig. 201 Oil temperature transmitter connection

OIL PRESSURE TRANSMITTER - MAINTENANCE PRACTICES

1. Removal/Installation - Oil Pressure Transmitter with warning light switch

A. Remove the oil pressure transmitter and low oil pressure warning light switch (fig.201).

CAUTION: ENSURE THAT THE ELECTRICAL SUPPLY TO THE TRANSMITTER IS OFF.

(1) Disconnect the electrical connections at the oil pressure transmitter and the low oil pressure warning light switch.

(2) Remove the four nuts and washers, securing the mounting bracket to the compressor interstage casing, remove the bonding lead and withdraw the bracket complete with the transmitter and pressure switch, easing the oil transfer tube from the compressor.

NOTE: The mounting bracket is flexibly mounted to the compressor interstage casing on rubber bush and steel ferrule assemblies; take care to retrieve the ferrules during removal.

(3) Remove the four nuts, washers, bonding lead and bolts and the two locating bushes securing the transmitter and pressure switch to the bracket, then remove the units from the bracket; remove the oil transfer tube.

B. Install the oil pressure transmitter and low oil pressure warning light switch.

CAUTION: (1) TO ENSURE THE INSTRUMENT FUNCTIONS CORRECTLY, REMOVE THE BLANKING SLEEVE (FITTED WHEN TRANSMITTER IS IN STORAGE TO PROTECT THE SMALL ATMOSPHERIC VENT IN THE MOUNTING PLATE OF THE ELECTRICAL CONNECTION SOCKET) ON REPLACEMENT TRANSMITTERS BEFORE MAKING THE ELECTRICAL CONNECTION.

(2) ENSURE THAT THE ELECTRICAL SUPPLY TO THE TRANSMITTER IS OFF.

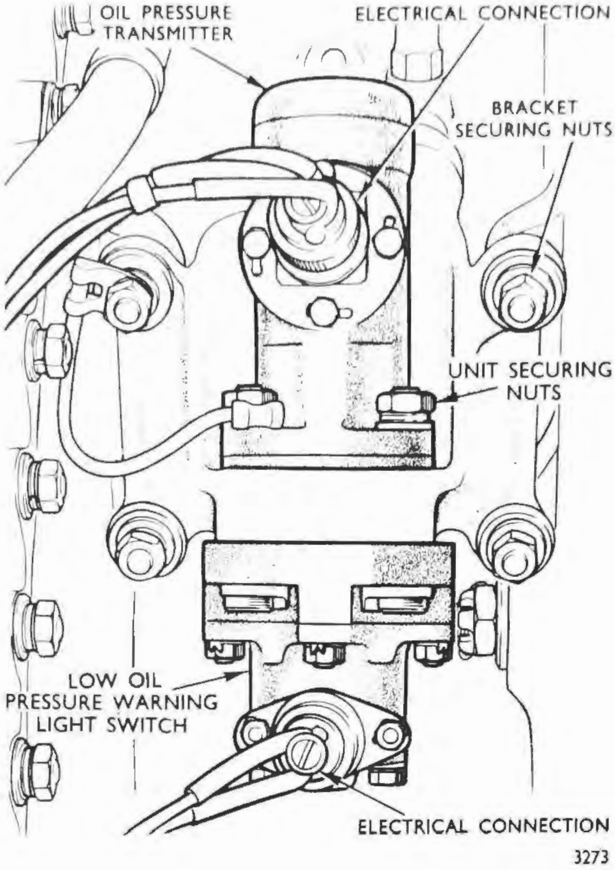
(1) Ensure that the mating faces on the transmitter, pressure switch and mounting bracket are clean and free from damage.

(2) Secure the transmitter and pressure switch (fig.201) to the mounting bracket as follows:

(a) Fit new jointing washers between the mounting bracket and the mating faces of the transmitter and pressure switch.

(b) Fit the two larger diameter bolts downwards through the inner pair of holes in the transmitter flange.

Oil pressure transmitter - Maintenance practices (cont.)



Oil pressure transmitter and warning light switch removal details
Fig.201

(c) Fit the remaining two bolts and locating bushes, inserting them upwards through the outer pair of holes in the pressure switch flange.

(d) Fit the bonding lead, washers and four nuts to the bolts and tighten to the standard torque value (89-0).

(3) Ensure the oil transfer tube is clean, fit new rubber sealing rings (lightly lubricated with engine oil) then insert transfer tube into the transmitter.

(4) Fit a ferrule assembly to each of the mounting bracket support feet then fit the mounting bracket and unit assemblies to the securing studs, guiding the oil transfer tube into its connection on the compressor casing.

(5) Fit the bonding lead, washers and four nuts to the securing studs and tighten to the standard torque value (89-0).

Oil pressure transmitter - Maintenance practices (cont.)

(6) Connect the electrical connections to their respective sockets on the transmitter and pressure switch and wirelock the connections.

(7) Check the unit as described in 2. Adjustment/Test.

2. Adjustment/Test (transmitter)

A. Serviceability check

(1) Replenish the oil system (72-8).

(2) Ground run the engine (71-0) and check the indicated oil pressure is consistent with engine operating conditions.

(3) On completion of engine ground run, examine the transmitter, pressure switch and the oil transfer tube and ensure there is no leakage.

3. Inspection/Check

A. Check the transmitter and its mounting bracket, the electrical connection and the oil transfer tube for security.

B. Visually examine the transmitter and oil transfer tube for damage, corrosion and oil leaks.

NOTE: If oil leakage is apparent from either the transmitter or the low oil pressure warning light switch, the defective unit must be changed and the connecting electrical leads examined for possible oil contamination. If a'Rolls-Royce supplied' L.T. harness is fitted the remaining connections in the harness must be examined for oil penetration. If it is suspected that oil has reached the main conduit the harness must be changed.

4. Adjustment/test (low oil pressure warning light switch)

A. Serviceability check

(1) Replenish the oil system (72-8).

(2) Ground run the engine and check that the warning light switch operates consistent with engine operating conditions (71-0).

(3) On completion of ground run, examine the pressure switch, transmitter and oil transfer tube for signs of leakage.

B. Check and set the warning light switch.

(1) If it is necessary to check and/or set the warning light switch, test equipment consisting of, at least, the following components, will be required:

(a) Hand operated oil pump.

(b) Pressure gauge (0 - 100 p.s.i. range)

(c) Suitable adapter.

(d) Indicator lamp and leads.

(e) Supply voltage of between 24V and 28V D.C.

(2) Check the switch as follows:

(a) Remove the switch from the engine; using the adapter, connect the gauge and pump pressure line to the switch, coupling the gauge as near as possible to the switch.

(b) Connect the test indicator leads to the switch and power supply and connect the other side of the power supply to the switch. The lamp should illuminate when the switch is closed (less than 5 p.s.i.).

(c) Pressure test the switch to the max. pressure (indicated by the manufacturer on the switch plate); check that there is no pressure drop or leakage.

(d) Release the pressure slowly and check that the switch closes when the pressure is between 5 and 6 p.s.i. Repeat the reducing pressure check twice more to ascertain the switch is fully operative and consistent.

(3) Adjust the switch.

(a) Remove the two 2 B.A. nuts and washers securing the flame trap cover to gain access to the adjusting screw.

(b) Push the adjusting screw in to release the ratchet type locking mechanism: turn the screw clockwise to increase the setting (i.e. increase the oil pressure) at which the switch opens; turn the adjusting screw anti-clockwise to reduce the setting.

NOTE: There are 12 locking positions for one complete rotation of the adjusting screw; ensure that the adjusting screw returns after adjustment to engage positively in one of these positions.

(c) Check the switch as in (2) after each adjustment.

(d) When the switch has been satisfactorily set, fit the flame trap cover then fit the switch to the engine.

5. Inspection/check (low oil pressure warning light switch)

A. Check the pressure switch and electrical connection for security.

B. Examine the pressure switch for signs of damage and corrosion.

C. Examine the joint face of the pressure switch to bracket and ensure that there are no leaks.

DESCRIPTION

STARTER SYSTEM

For ground starting of the engine, the main shaft is rotated by a starter motor, air is drawn into the engine by the action of the compressor, and is forced into the combustion chambers to mix with the fuel spray. Combustion is initiated by a high voltage electrical discharge adjacent to the spray, the whole starting sequence being governed by an automatic control circuit which de-energizes the system when the engine has become self-sustaining.

The engine installation has two high energy units, each unit being connected to a surface discharge igniter plug situated in No. 3 and 7 combustion chambers to produce an instantaneous high intensity spark to ignite the main fuel spray. When the spray from the burner lights up, the flame spreads rapidly around the engine through balance pipes interconnecting the combustion chambers.

For relighting in flight the igniter system is separately energized, as operation of the starter motor is not needed because the engine will 'windmill'.

The starter is a 4-pole, compound-wound 28-volt motor producing about twelve horse-power; this relatively small power output must therefore be applied over a fairly long period to ensure that the engine reaches starting speed.

The armature assembly is supported by a ball bearing at the outer end and by a roller bearing at the driving end, each bearing being pre-packed with grease on assembly. An oil seal is fitted at the driving end to exclude oil mist from the motor.

Starting torque is transmitted to the engine through a spring-loaded multi-plate clutch which protects the starter drive from excessive shock loading. The drive from the clutch is transmitted to the starter engaging mechanism by an inclined shaft and bevel gearing which provides the speed reduction necessary to enable the starter motor to develop full torque.

STARTER MOTOR - MAINTENANCE PRACTICES

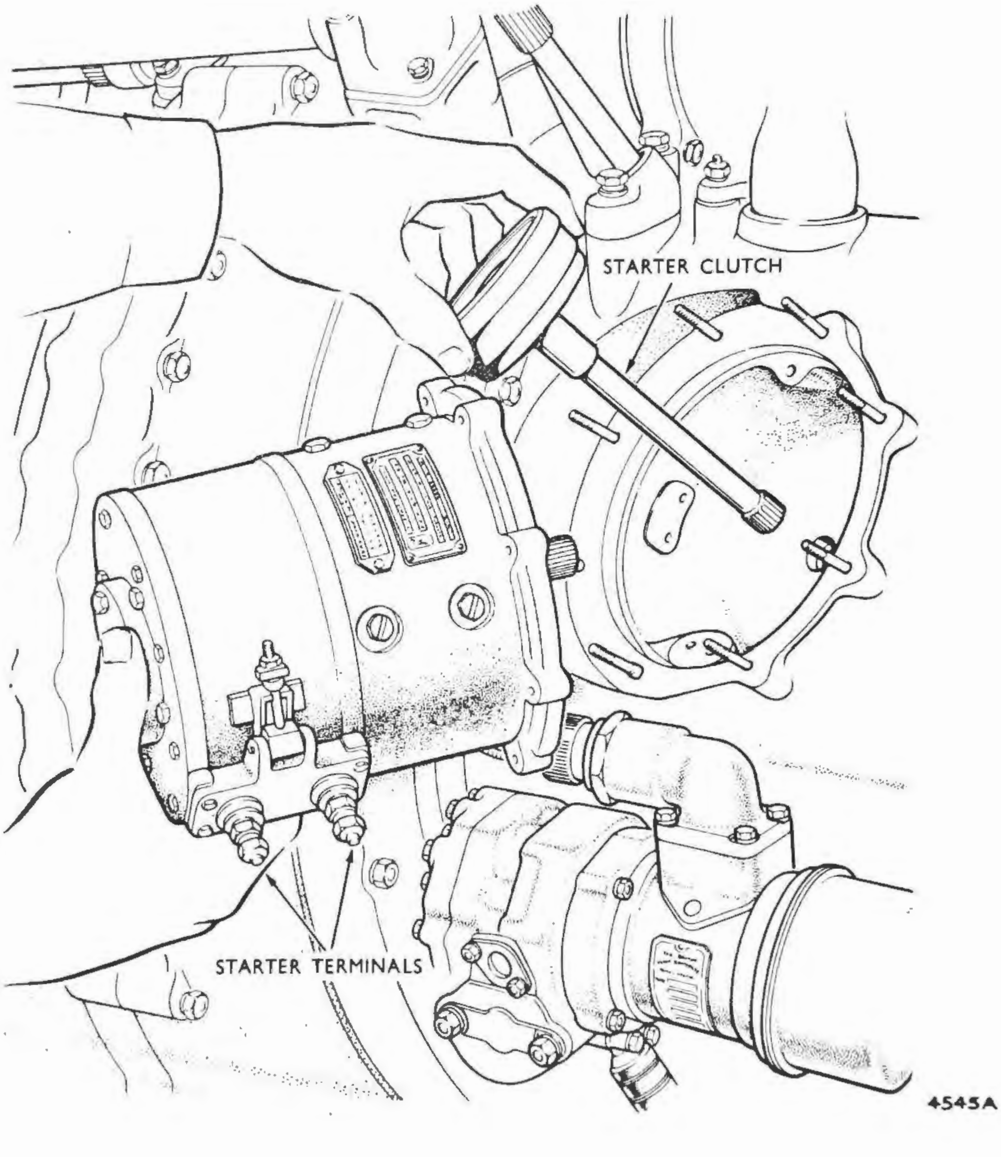
1. Removal/Installation

A. Remove the starter motor

(1) Disconnect the two electrical leads.

(2) Remove the retaining nuts, plain washers and spring washers and withdraw the starter motor from the engine; discard the jointing.

(3) Withdraw the clutch drive assembly.



Starter motor and clutch drive assembly
Fig.201

Starter motor - Maintenance practices (cont.)

B. Install the starter motor

(1) Prime the starter motor immediately prior to fitting the unit to the engine.

(a) Place the motor so that the oil pocket in the driving end cover is in a vertical position, then fill the pocket with clean engine oil until the oil flows out past the armature shaft.

(b) Stand the motor on the commutator end so that the oil can flow around the oil seal lip.

(2) Fit the clutch drive assembly into the starter motor housing on the engine ensuring that the drive splines mate satisfactorily with those in the engine.

(3) Place a jointing in position and fit the starter motor, correctly located on the dowel stud, to its mounting ensuring that the terminals are correctly positioned and that the splines on the starter armature shaft are a good sliding fit in the clutch drive.

NOTE: It may be necessary to rotate the engine to engage the starter motor splines.

(4) Secure the starter motor with plain washers, spring washers and retaining nuts; torque tighten the nuts to the loading specified in Chap.89-3.

(5) Fit the starter motor leads to the terminals and secure them with plain washers, spring washers and nuts; torque tighten the nuts to the loading specified in Chap.89-3.

2. Inspection/Check

A. Check the starter motor

(1) Remove the cover band from the motor, taking care not to damage the cork lining of the band, and blow out with moisture free compressed air any accumulation of carbon and copper dust.

(2) Check the brushes for freedom in their holders and, if necessary, remove and clean them with fine emery cloth on a flat surface.

(3) Connect one lead of a 250 - volt megger tester to either one of the starter motor terminals and connect the other lead to the starter motor casing, then check that the insulation resistance is not less than 50,000 ohms.

(a) If the insulation check is unsatisfactory, remove the starter motor from the engine to permit further inspection and air blowing.

(b) Check that no carbon and copper dust still adheres to any oil film around the motor lead-ins before rejecting the unit for low insulation.

3. Adjustment/Test

A. Test the starter motor

(1) Motor the engine over as instructed in 'Adjustment/Test', Chap.71-0 or 72-0 as appropriate, and check that the engine speed obtained is not less than 1,800 r.p.m.

DESCRIPTION

IGNITER PLUGS

The igniter plugs are fitted in No. 3 and 7 combustion chambers.

Each plug consists of a centre and an earth electrode separated by a semi-conductive insulator. The spark or discharge is initiated by a slight electrical leakage across the surface of the insulator, from the centre electrode to earth, providing a low resistance path for the condenser discharge. The operation of the plug is not adversely affected by carbon build-up, which may even improve the electrical leakage on which the efficiency of the plug depends.

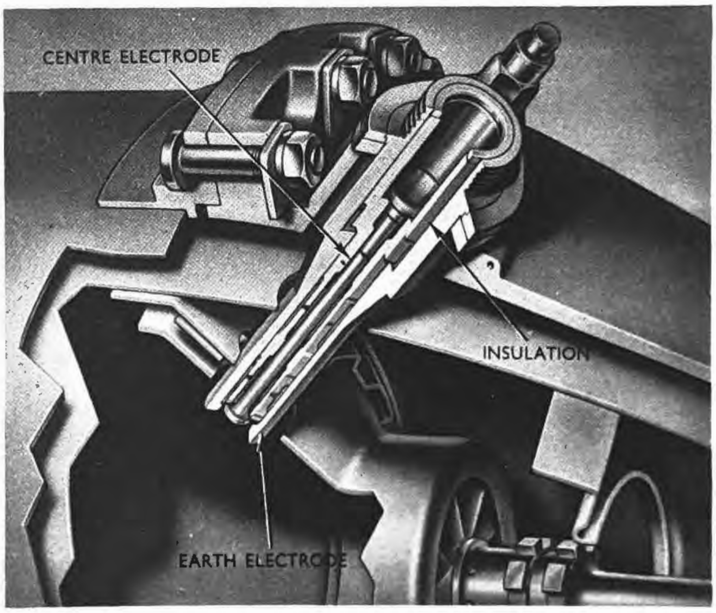


Fig. 1 H.E. igniter plug

IGNITER PLUGS AND LEADS - MAINTENANCE PRACTICES

1. Removal/Installation (Fig.201)

WARNING: THE ELECTRICAL ENERGY STORED IN THE CONDENSER OF A HIGH-ENERGY IGNITION UNIT IS POTENTIALLY LETHAL. BEFORE TOUCHING THE UNIT, H.T. LEAD OR IGNITER PLUG DISCONNECT THE L.T. SUPPLY FROM THE IGNITION UNIT AND WAIT FOR AT LEAST ONE MINUTE TO ALLOW ANY STORED ENERGY TO DISSIPATE.

A. Remove igniter plug

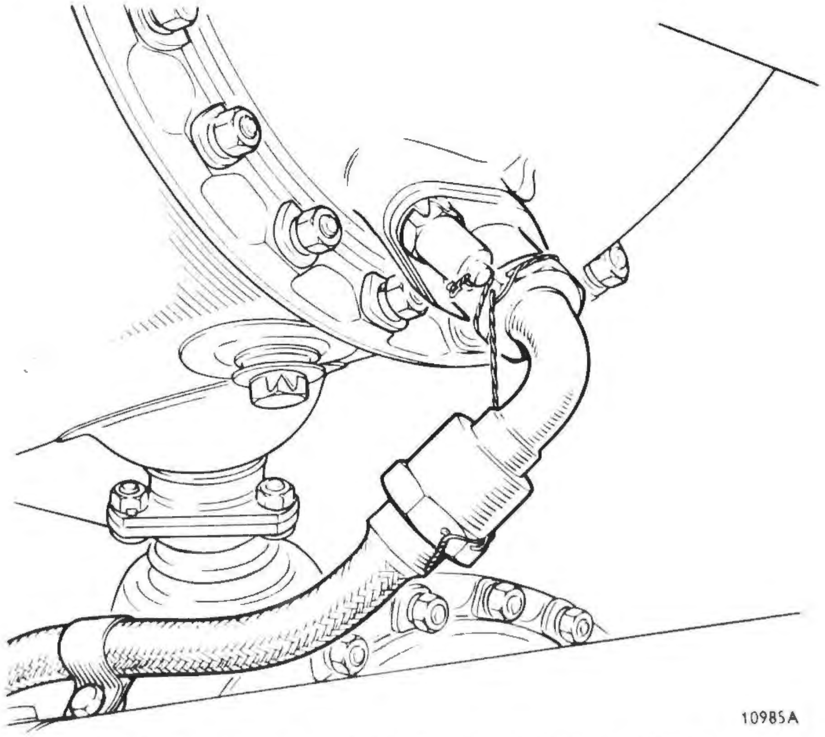
(1) Remove the locking wire, unscrew the nut and disconnect the H.T. lead from the igniter plug.

(2) Bend back the locking tabs, unscrew the two capnuts and remove the igniter plug and distance piece from the combustion chamber; discard the tabwashers.

B. Install igniter plug

(1) Clean the joint faces on the igniter plug flange, distance piece and combustion chamber, then smear them lightly with the jointing compound specified in 89-1.

(2) Fit the distance piece and igniter plug to the combustion chamber and secure them with two new tabwashers, a plain capnut and a capnut with a locking wire anchor point; tighten the capnuts to the torque load specified in 89-3 and bend up the locking tabs.



Igniter plug and H.T. lead connection
Fig.201

(3) Connect the H.T. lead to the igniter plug, tighten the nut to the torque load specified in 89-3, ensuring that the lead makes good contact with the plug (3. Inspection/Check), then wire lock the H.T. lead connection as shown in Fig.201 using 22 s.w.g. stainless steel wire.

2. Adjustment/Test

WARNING: DO NOT FUNCTION CHECK ANY PART OF THE IGNITER SYSTEM BY REMOVING THE IGNITER PLUG TO VIEW THE SPARK, OR BY DISCONNECTING THE H.T. LEAD TO MAKE AN AIR GAP BETWEEN THE END OF THE H.T. LEAD AND THE PLUG OR ANY PART OF THE ENGINE, AS THIS COULD RESULT IN FATAL PERSONAL INJURY AND SERIOUS DAMAGE TO THE ENGINE.

A. Function check igniter system

CAUTION: BEFORE CHECKING THE IGNITERS ENSURE THAT ANY RESIDUAL FUEL IN THE COMBUSTION CHAMBERS IS BLOWN OUT BY SUBJECTING THE ENGINE TO A MOTORING CYCLE.

NOTE: (1) The use of igniter systems during abnormal icing conditions can seriously affect the life of the ignition units. The accumulated recorded time of such use should be taken into account, therefore, together with normal use during starting, when assessing unit life.

(2) To preclude the possibility of both units failing simultaneously during an emergency, the two units on any one engine should, if possible, be so lifed that there is maximum 'stagger' between them.

(1) Function check the igniter system and ensure that both igniters function satisfactorily as follows:

(a) Set the Starter Master Switch to SAFE and ensure that the H.P. cock levers are CLOSED.

(b) Operate the igniter test switch or relight switch and listen for the sharp 'cracks' of the electrical discharge across the plug electrodes.

(2) If failure of one igniter plug is evident during the check, observe the warnings and disconnect the L.T. supply from each ignition unit in turn and check each circuit individually to isolate the defect.

NOTE: Confine operation of the igniter system to the minimum time necessary to verify satisfactory functioning of the igniters.

B. Test H.T. leads

If an igniter circuit does not function satisfactorily, test the H.T. lead as described in '3. Inspection/Check' before changing the igniter plug and/or ignition unit.

3. Inspection/Check

A. Function check the igniter system as described in '2. Adjustment/Test' and ensure that both igniter plugs function satisfactorily.

B. At engine installation and at the recommended inspection periods, check each igniter H.T. lead as follows:

(1) Check the lead-in elbow/igniter plug connection (Fig.201) for tightness, security of attachment and correct locking.

(2) If the elbow is loose, unlock the nut, then tighten and wire lock it as described in '1. Removal/Installation B.(3)'.

(3) If the elbow is still loose after tightening the nut, disconnect the lead from the plug and inspect the copper spring retaining washer for spreading and security; if the washer has spread or is loose, change the H.T. lead, but if it is serviceable, the securing nut is probably bottoming on the igniter plug flange and the plug must be changed.

(4) Examine the metal braid/end-fitting soldered joint at each end of the lead for security of attachment.

C. At the recommended inspection periods, disconnect the H.T. lead from the ignition unit and igniter plug and remove the lead from the aircraft, then examine the lead and test it as follows:

(1) Examine the contact button at each end of the lead; remove light pitting with a fine file or wire brush. Clean the buttons and insulators thoroughly with trichloroethane to remove any residue. If a button is deeply pitted the lead must be rejected.

(2) Examine the insulators at each end of the lead for damage and check that there is no gap between each insulator and contact button, turning the insulator if necessary.

(3) Using a suitable D.C. electrical supply not exceeding 12 volts connected across the ends of the lead in series with a lamp or other suitable indicating device, test the inner conductor and check it for continuity; reject the lead if continuity is not indicated.

(4) Test the insulation resistance of the high tension lead.

CAUTION: INSERT A 200,000 OHMS RESISTOR IN THE TEST CIRCUIT CLOSE TO THE HIGH TENSION LEAD TO LIMIT THE CURRENT SHOULD BREAKDOWN OF THE INSULATION RESISTANCE OCCUR.

(a) Connect a 25 to 100 c.p.s. electrical supply peaking at 10,000 volts (7,100 root mean square) to the outer metallic conduit and each contact button in turn in series with a suitable electrostatic voltmeter and a 200,000 ohms resistor.

(b) Check that the high tension lead insulation can withstand a peak voltage of 10,000 volts for a duration of 3 to 5 seconds; if not, reject the lead and fit a serviceable replacement lead.

(5) Test the bonding circuit resistance of the high tension lead outer return conductor sheath and rigid end-fittings, using a Wheatstone bridge.

(a) Connect both rigid end-fittings of the high tension lead outer sheath to the terminals of a Wheatstone bridge with a pair of copper test leads of known resistance, not in excess of 0.020 ohms.

(b) Check that the total circuit resistance value of the braided sheath and rigid end-fittings does not exceed 0.050 ohms.

NOTE: The total circuit resistance value of the high tension lead is the Wheatstone bridge reading minus the resistance value of the test leads.

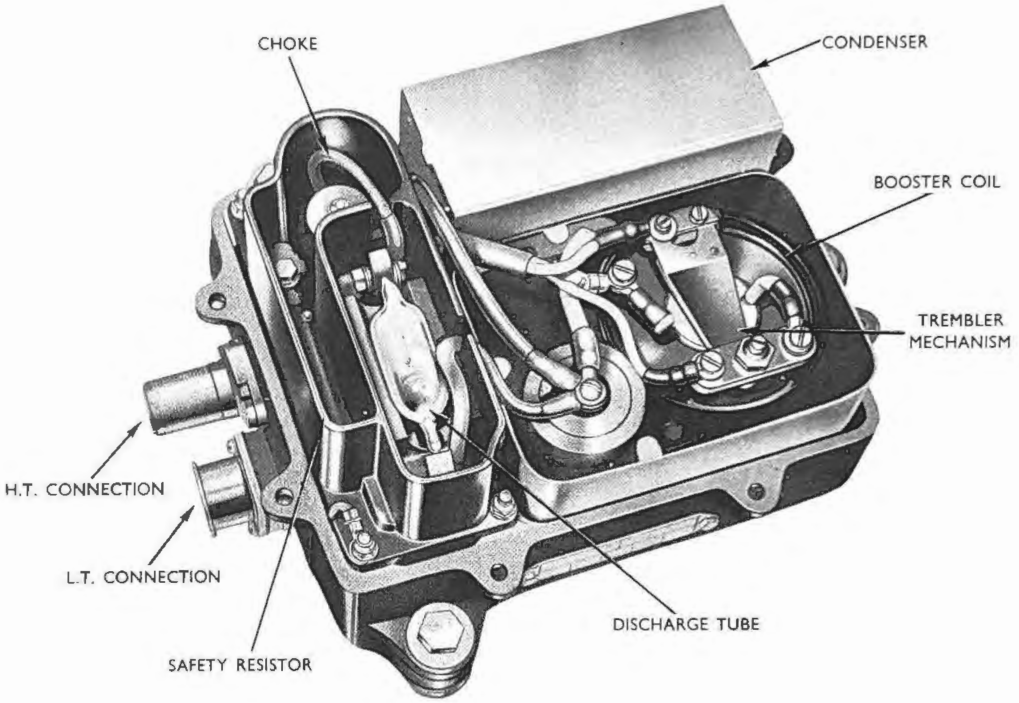
(c) If the circuit resistance value of the high tension lead is unsatisfactory, reject the lead and fit a serviceable replacement lead.

DESCRIPTION

IGNITER UNITS

Each engine has two igniter units which, when operated, are supplied with current from the aircraft 24-volt D.C. system and, to provide a safety factor, the units operate independently of each other.

A booster coil operated by a trembler mechanism, repeatedly charges a storage condenser through a high voltage rectifier. The rectifier prevents a back discharge into the coil windings, and the potential across the storage condenser builds up to a value of approximately 2,000 volts at which voltage the sealed



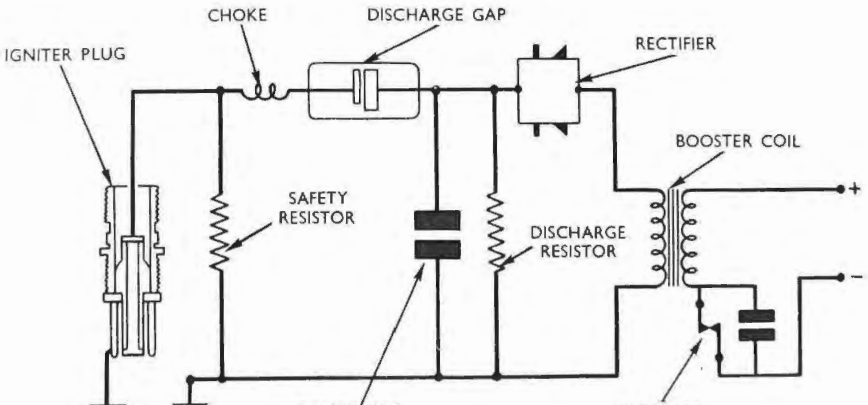


Fig. 1 H.E. igniter system

discharge gap is bridged. The condenser then discharges through the sealed gap, a choke, and the engine igniter plug, which are all connected in series. The condenser is then recharged, and the cycle repeated at a frequency of not less than one discharge per second; the stored energy per discharge is 12 joules.

A discharge resistor is connected across the storage condenser to ensure the dissipation of stored energy should the condenser be left in a stored condition when the unit is not in use. The safety resistor across the output circuit prevents the voltage building up within the unit, if the unit should be switched on while the igniter is disconnected. The choke controls the duration of the discharge to give the optimum ignition properties.

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CHAPTER 82 - WATER INJECTION

LIST OF ROLLS-ROYCE EFFECTIVE PAGES

This chapter consists of the following pages

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	2	Feb.28/58
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	203	Apr.30/67
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	201	May 27/68
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	203	May 27/68

DESCRIPTION

WATER/METHANOL SYSTEM

When the engine is operating under high ambient temperature conditions, with a corresponding decrease in mass air flow, fuel flow is reduced by the fuel trimmer to maintain engine temperature within acceptable limits. The resulting decrease in engine power is restored during take-off by automatically injecting a controlled flow of water/methanol mixture into the first-stage compressor through drillings in the rotating guide vanes and impeller (fig. 1).

Injection of the water/methanol is controlled by a metering unit, described in 82-1, which is sensitive to propeller shaft torque through torque meter oil pressure, ambient pressure through two opposed capsules, and engine speed by interconnection with the throttle and r.p.m. controls.

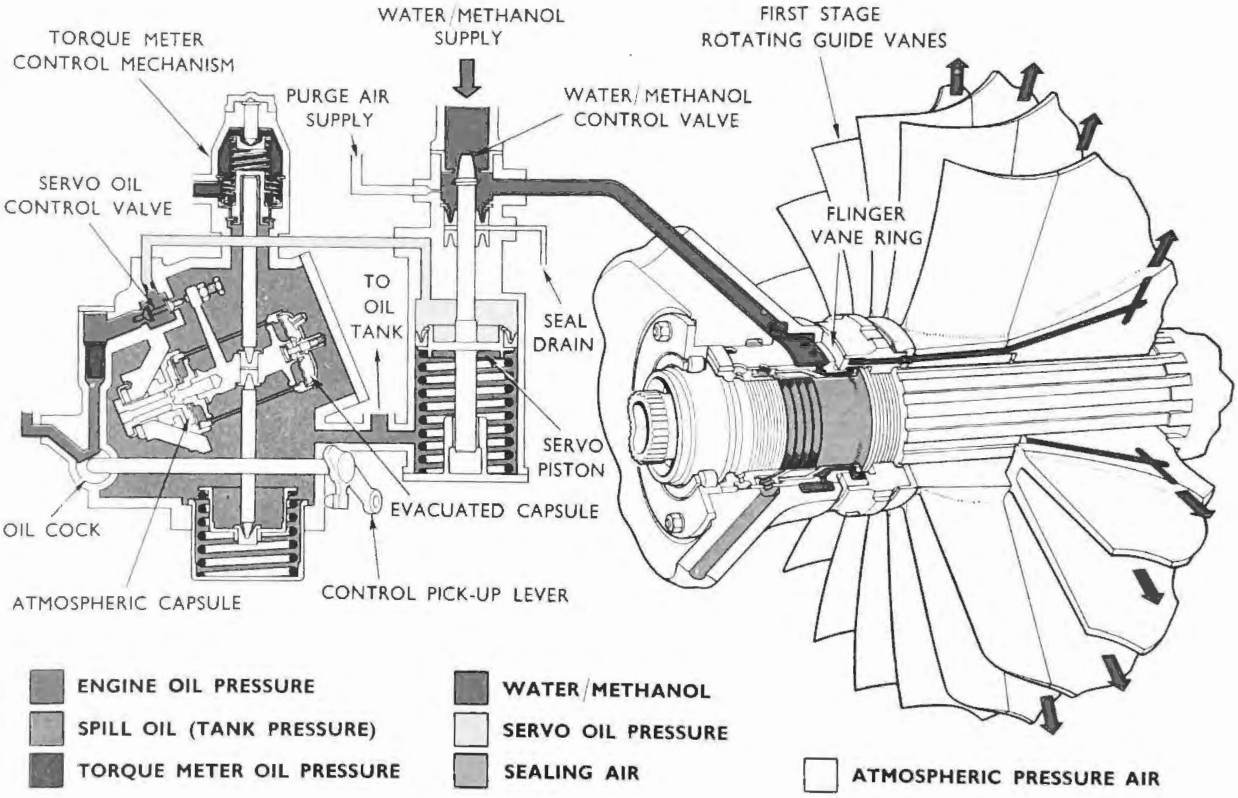


Fig. 1 Water/methanol system

DESCRIPTION

WATER METHANOL CONTROL UNIT

The water methanol control unit is mounted on the port side of the engine, and determines the amount of water/methanol discharged into the compressor according to engine requirements and outside air temperatures.

The flow of water/methanol is regulated by a control (metering) valve which is normally held in the closed position by spring pressure; this valve is opened when the servo control valve admits oil from the engine high pressure system to the servo cylinder. A restriction in the supply passage between the servo control valve and servo cylinder eliminates oscillation of the water/methanol metering valve and prevents engine hunting.

The servo control valve is arranged to meter engine oil pressure according to the forces acting on the capsule assembly stem.

Torque meter pressure, transmitted to the capsule stem through a piston and the upper push rod, tends to close the servo valve. This force is opposed by spring pressure transmitted through the lower push rod tending to open the servo valve.

The effect of atmospheric pressure on the capsule assembly modifies the forces operating through the push rods on the control assembly and renders the unit sensitive to altitude. Out-of-balance forces permit movement of the servo control valve to vary the servo oil pressure which acts on the metering valve to control the water/methanol flow into the engine.

The capsule assembly consists of two capsules, one evacuated and the other open to ambient pressure. The capsules are arranged to move the servo control valve towards the closed position when atmospheric pressure decreases; this controls take-off power to the I.S.A. value at the particular aerodrome altitude.

As the water/methanol is vaporized on passing through the compressor, it both reduces the temperature of the air and increases the mass flow. The increased mass flow reduces the turbine inlet temperature and enables water/methanol burnt in the combustion chambers to restore engine power to that obtainable at I.S.A. conditions without increasing the turbine gas temperature above the operating limitations.

Engine power is thus varied due to the effect of the water/methanol until the resulting torque meter pressure balances the opposing forces and equilibrium is reached.

With the injection system switched on, water/methanol is supplied to the unit as the throttle approaches the take-off position when, by means of control interconnection, the oil cock in the unit is opened to permit engine oil to reach the servo control valve.

To prevent corrosion, a supply of air is tapped from the first-stage impeller casing to purge all residual water/methanol from the control unit and from the supply passages in the impeller.

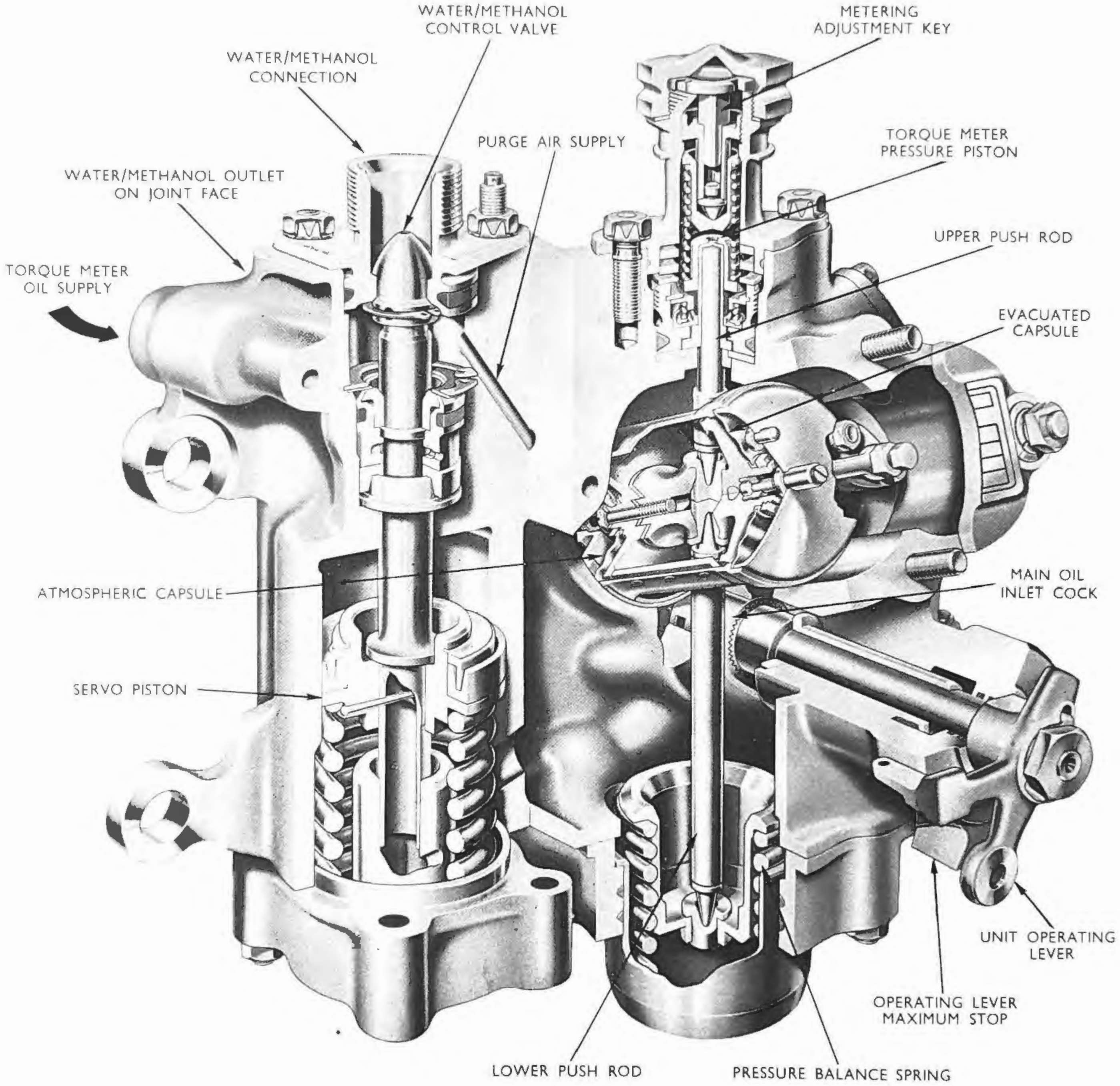


Fig. 1 Water/methanol control unit

WATER/METHANOL CONTROL UNIT - MAINTENANCE PRACTICES

WARNING: THE VAPOUR GIVEN OFF BY METHANOL IS TOXIC, AND METHANOL MUST, THEREFORE, ONLY BE STORED AND HANDLED IN WELL VENTILATED PREMISES. TO ENSURE THAT METHANOL DOES NOT CONTACT THE SKIN WHEN INSPECTING OR SERVICING THE WATER/METHANOL SYSTEM, RUBBER GLOVES AND PROTECTIVE CLOTHING SHOULD BE WORN.

CAUTION: (1) SCRUPULOUS CLEANLINESS IS ESSENTIAL WHEN FILLING THE WATER/METHANOL TANKS AND WORKING ON THE SYSTEM. TO PREVENT CORROSION, IMMEDIATELY WIPE UP ANY MIXTURE SPILT ON THE ENGINE OR POWER PLANT.

(2) THE PROPORTIONS OF WATER TO METHANOL ARE CRITICAL AND THE ADDITION OF ANY EXTRA COMBUSTIBLE LIQUID SUCH AS KEROSINE CAN CAUSE INTERNAL ENGINE EXPLOSION AND OVERHEATING OF THE TURBINE ASSEMBLY, RESULTING IN SEVERE DAMAGE TO THE ENGINE. IF KEROSINE ENTERS THE SYSTEM IT MUST BE DRAINED AND PURGED BEFORE RUNNING THE ENGINE. CLEANLINESS IS ESSENTIAL DURING MIXING OF WATER/METHANOL AND WHEN SERVICING THE SYSTEM. REPLACEMENT UNITS MUST BE PURGED BEFORE INSTALLATION.

1. Removal/Installation (Fig.201)

A. Remove water/methanol control unit

(1) Remove the auto-feathering switch as described in Chap.82-2.

(2) Disconnect the control rod from the operating lever on the control unit.

(3) Unlock and disconnect the water/methanol supply pipe and torquemeter oil pressure transmitter pipe.

(4) Disconnect the drain pipe at the fuel pump end and remove the retaining clip from the air intake casing, then disconnect the drain pipe from the water/methanol control unit.

(5) Disconnect the fire extinguisher pipe and, on pre-Mod.906 engines, the fuel control unit ram air pipe clip, from the right-hand side of the unit, and disconnect the oil temperature bulb electrical cable clip from the base of the unit.

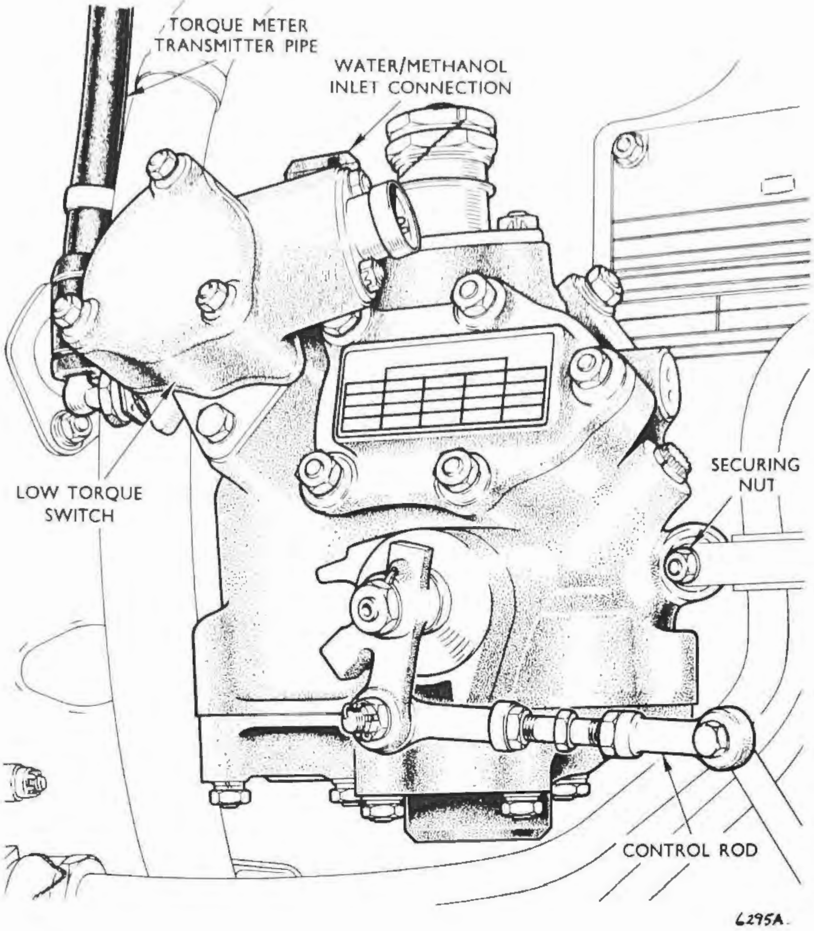
(6) Remove the four nuts, spring and bevelled washers securing the unit to the air intake casing, and fit the extractor HW.34468 and withdraw the unit from the mounting studs; collect the rubber bush and steel ferrule flexible mounting assemblies from the mounting feet when the unit is removed.

(7) Remove the extractor from the unit, then withdraw the transfer tubes from the engine air intake casing or the unit, using the extractor tools HW.11455 and HW.15065. Remove and discard all rubber sealing rings.

NOTE: Ensure that the extractor is of the correct size for the transfer tube being withdrawn.

(8) Drain the unit and flush the water/methanol passages with clean engine oil, drain again, then blank off all passages.

Water/methanol control unit - Maintenance practices (cont.)


TORQUE METER TRANSMITTER PIPE
WATER/METHANOL INLET CONNECTION
LOW TORQUE SWITCH
SECURING NUT
CONTROL ROD
6295A

Water/methanol control unit removal details
Fig.201

B. Install W/M control unit

NOTE: (1) Before installing a new W/M control unit observe the water/methanol check pressure (W.M.C.P.) recorded on the engine Data plate. If the Data plate W.M.C.P. exceeds 460 p.s.i., a Mod.1369 unit should be fitted as the range of adjustment on pre-Mod.1369 units is insufficient to allow a higher torquemeter oil pressure setting. If the Data plate W.M.C.P. exceeds 490 p.s.i., however, Mod.1369 units will require increased shimming on the main spring and, where possible, the thickness of the washer should be increased by 0.100 in. (approx.), as described in '2. Adjustment/test' as the range of adjustment on these units is insufficient to allow a higher torquemeter pressure setting.

(2) If a new W/M control unit is to be fitted, remove the blanks and drain off any inhibiting fluid.

(1) Fit new rubber sealing rings to all transfer tubes in accordance with the instructions in 89-7 and smear the exposed surfaces with the lubricant specified in 89-1.

Water/methanol control unit - Maintenance practices (cont.)

(2) Refit the transfer tubes in their respective bores in the W/M control unit.

(3) Check the rubber bushes of the anti-vibration mounts for oil soakage or deterioration and renew if necessary, then assemble the rubber bushes and steel ferrules in the bores in the control unit mounting feet.

(4) Locate the unit on the mounting studs, fit the bevelled and spring washers and the nuts to the studs and tighten the nuts to the torque load specified in 89-3.

(5) Refit the low-torque switch as described in 82-2.

(6) Refit the drain pipe, torquemeter oil pressure transmitter pipe and water/methanol supply pipe, and secure the oil temperature bulb electrical cable, extinguisher pipe and F.C.U. ram air pipe (pre-Mod.906) clips to the clipping points on the control unit; lock all pipe connections using 22 s.w.g. stainless steel wire.

(7) Connect the control rod to the lever on the unit and set the water/methanol controls as described in Chapter 76.

NOTE: If a new unit has been installed, adjust it provisionally by assessment from its nominal setting of 375 p.s.i. (pre-Mod.1369) or 405 p.s.i. (Mod.1369) to the W.M.C.P. given on the engine Data plate, taking into consideration any adjustment of main spring washer thickness which may have been made before installation of the unit; increasing washer thickness by 0.100 in. increases the setting by 50 p.s.i. (approx.). This initial setting will prevent engine power exceeding the maximum limit during the water/methanol check run. The method of adjustment is given later in '2. Adjustment/Test'.

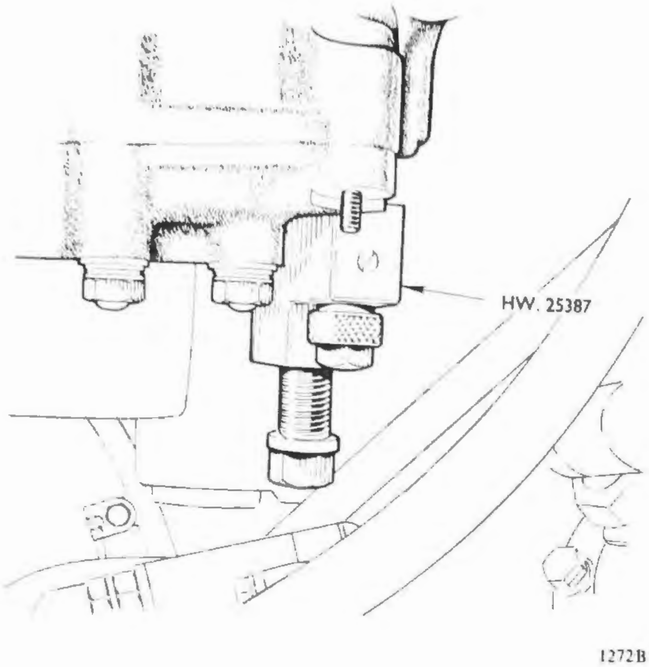
(8) Function test the W/M control unit and adjust the torquemeter pressure, if necessary, as described in '2. Adjustment/Test'.

(9) On completion of the first ground run after installation check the water/methanol control unit and pipe connections for leaks.

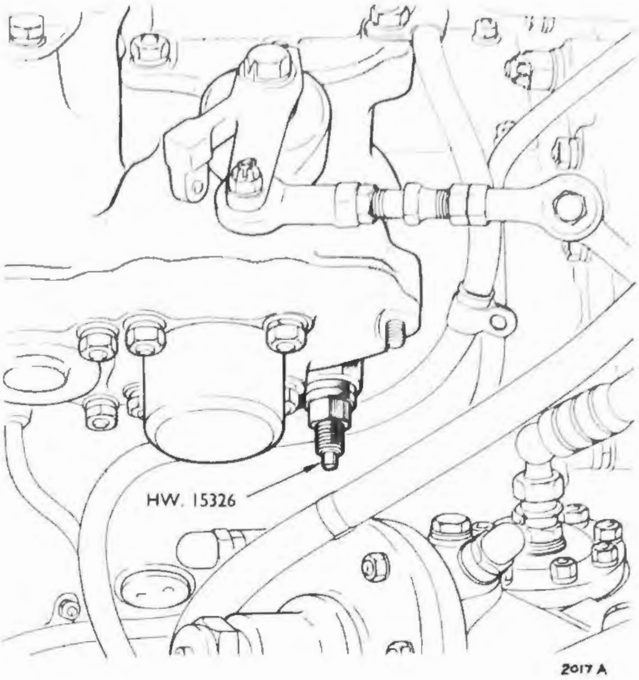
C. Remove oil filter

(1) Disconnect the clips securing the oil temperature bulb cable, fire extinguisher pipe and F.C.U. ram air pipe (pre-Mod.906) to the W/M control unit, and remove the extinguisher pipe to allow access to the filter.

(2) Remove the nut, spring washer and bevelled washer securing the filter cover to the housing, and withdraw the cover using the extractor HW.25387 (Fig.202).



Removal of oil filter cover
Fig.202



Removal of oil filter
Fig.203

(3) If the filter remains in the housing, withdraw it using the extractor tool HW.15326. Insert the centre piece of the tool into the filter recess and locate the bush over the filter housing aperture, then tighten the nut on the bush and withdraw the filter.

D. Install oil filter

(1) Renew the filter or clean it carefully in clean kerosine or white spirit and dry off with a moisture-free compressed air blast.

NOTE: If the engine is not to be run immediately immerse the filter in clean engine oil prior to installation.

(2) Refit the filter in the bore of its housing in the W/M control unit.

(3) Renew the sealing ring in the filter cover, fit the cover to the control unit and secure it with the nut, spring washer and bevelled washer.

(4) Refit the fire extinguisher pipe, then secure the ram air pipe (pre-Mod. 906), extinguisher pipe and oil temperature bulb cable clips to the clipping points on the control unit.

(5) Function test the W/M control unit as described in '2. Adjustment/Test'.

Water/methanol control unit - Maintenance practices (cont.)

2. Adjustment/test

A. Function test water/methanol control unit

Run the engine and carry out the water/methanol injection check described in 71-0, Adjustment/Test; if necessary, adjust the torquemeter oil pressure as described in 2.B.

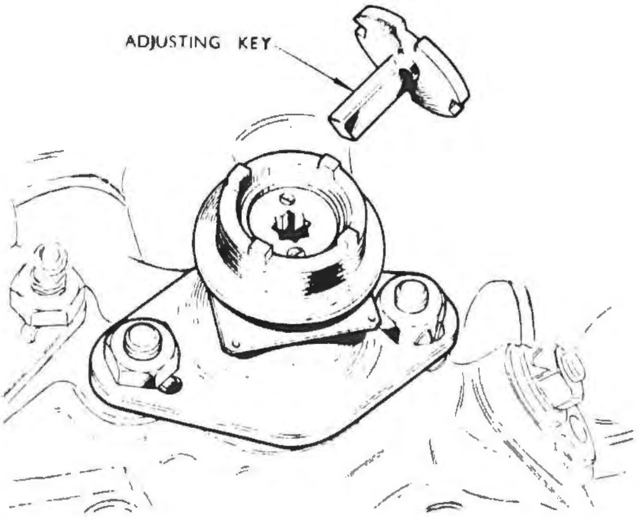
B. Adjust water/methanol control unit

NOTE: The unit must only be adjusted to restore water/methanol torquemeter pressure to the W.M.C.P. recorded on the engine Data plate, corrected for pressure altitude. Do not make indiscriminate adjustments in an endeavour to give additional take-off power. The amount of adjustment required will be determined during the water/methanol injection check run.

(1) Unlock and remove the domed nut adjacent to the inlet connection and lift the locking device thus exposed clear of the castellations, refer to Fig.204; remove and discard the crush-washer.

(2) Using the square shank of the locking device as a key, turn the adjuster; turning the adjuster anti-clockwise increases the rate of injection and, thus, the controlling torquemeter pressure. One-eighth of a turn equals approximately 2 p.s.i.(pre-Mod.1369) or 3 p.s.i. (Mod.1369) torquemeter pressure. If the range of external adjustment is insufficient, adjust the main spring washer as described in C. or D. as appropriate.

NOTE: Adjustment must be made in multiples of one-eighth of a turn to enable the locking plate to engage with the castellations after adjustment; it may be necessary to reposition the locking device in the centre adjustment to obtain correct engagement.



Adjustment of water/methanol control unit
Fig.204

Water/methanol control unit - Maintenance practices (cont.)

(3) Fit a new aluminium crush-washer, then refit the domed nut and wire-lock it to the anchor point.

(4) Function test the water/methanol control unit as described in 2.A.

C. Adjust main spring washer (water/methanol unit in position on engine)

NOTE: Refer to D. NOTES (1) and (2).

(1) Using firm hand pressure, hold the main spring cover against the spring pressure, remove the 5 nuts, spring and bevelled washers securing the cover then carefully remove the cover together with the main spring, adjustment washers, spring carrier and push-rod, refer to Fig.205.

NOTE: The spring cover must not be disturbed or separated from the housing as this would necessitate removal of the rubber sealing ring.

(2) Proceed with D. (5) to (7) inclusive.

(3) Locate the push rod and carrier in the water/methanol unit, ensuring that the conical ends of the push rod are located correctly in the capsule stem and main spring carrier then fit the main spring and cover assembly in position.

(4) Repeat D.(9).

(5) Re-set the external torquemeter adjustment provisionally to allow for the change of main spring adjusting washer thickness, taking into consideration the initial setting of the unit, to ensure that the W.M.C.P. recorded on the Data plate is not exceeding during the initial ground run.

(6) Repeat D. (11).

D. Adjust main spring washer (water/methanol unit removed)

NOTES: (1) A range of 4 main spring adjusting washers are provided which vary in thickness from 0.075 in. to 0.150 in. in graduations of 0.025 in., thus allowing adjustment of washer thickness by increments of 0.025 in. between 0.075 in. and 0.275 in. Not more than 2 washers must be fitted and the total thickness of washers must not exceed 0.275 in. (pre-Mod.1588) or 0.300 in. (Mod.1588, S.B.Da No.82-14). Increasing washer thickness by 0.050 in. increases the torquemeter pressure setting by 25 p.s.i.

(2) Some water/methanol control units may not have a shim fitted under the main spring, and where there is insufficient adjustment in the 'screw up' position (i.e. maximum torque too low), an adjusting washer can be fitted, but if there is insufficient adjustment in the 'screw down' position (i.e. minimum torque too high), the unit must be rejected.

(1) Remove the water/methanol control unit as described in '1.A. Removal/ Installation'.

(2) Position the unit on a bench with the main spring cover uppermost, (refer to Fig.205).

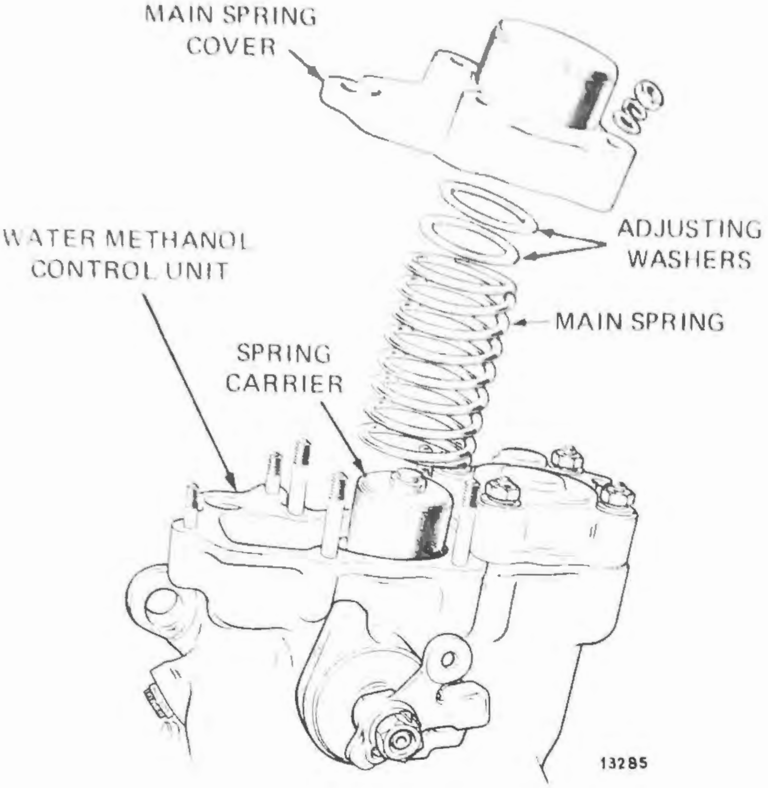
(3) Remove the 5 nuts, spring and bevelled washers securing the main spring cover, hold the cover down against the spring pressure and carefully release the cover.

(4) Lift off the cover together with the main spring and any adjustment washers, leaving the spring carrier and push rod in position.

NOTE: The spring cover must not be disturbed or separated from the housing as this necessitates renewal of the rubber sealing rings.

(5) Remove the main spring and any adjusting washer from the cover (refer to Fig.205) measure the thickness of the washer and calculate the dimension required as follows:

(a) If there is insufficient external adjustment in the 'screw-down' position i.e. minimum torque too high, select an adjusting washer from the range to decrease the thickness by 0.050 in. If no washer has been fitted, or reduction in washer thickness is not possible, reject the unit.



Removal of main spring adjusting washer
Fig.205

(b) If there is insufficient external adjustment in the 'screw-up' position, (i.e. maximum torque too low), select an adjusting washer from the range to increase the existing washer thickness by 0.050 in. If no washer is fitted, select the thinnest washer in the range (0.075 in.). If the required adjustment increases the total thickness of the washers to more than 0.275 in. (pre-Mod.1588), or 0.300 in. (Mod.1588, S.B.Da.No.82-14) or it is necessary to fit more than 2 adjusting washers, reject the unit.

(6) Clean the joint faces on the main spring cover and the control unit casing, ensuring that there are no damage marks, then apply a thin coat of the jointing compound specified in 89-1 to both joint faces in accordance with the instructions in 89-12.

(7) Locate the selected adjusting washers on the seating inside the main spring cover, then insert the main spring into the cover.

(8) With the base of the water/methanol control unit uppermost, lower the main spring and cover assembly on to the carrier, ensuring that the conical ends of the push-rod are correctly located in the capsule stem and main spring carrier.

(9) Press down the cover and compress the main spring until the joint faces of the cover and casing meet, fit the 5 bevelled washers, spring washers and nuts finger tight initially, then tighten the nuts evenly.

(10) Install the water/methanol control unit as described in '1.B.Removal/ Installation', and reset the external torquemeter adjustment provisionally to allow for the change of main spring adjusting washer thickness, taking into consideration the initial setting of the unit, to ensure that the W.M.C.P. recorded on the Data plate is not exceeded during the initial ground run after installation of the unit.

(11) Function test the water/methanol control unit,refer to 2.A.,and adjust if necessary as described in 2.B.

3. Inspection/check

A. Carry out the function test described in '2.A. Adjustment/Test', and check the unit for correct operation and adjustment.

B. Check the controls for full and free movement, and examine the control rod and lever for safety and correct locking.

C. Examine the water/methanol control unit and pipe connections visually for security of attachment, correct locking and signs of leaks.

4. Remove and install the servo piston seal

CAUTION: ENSURE SCRUPULOUS CLEANLINESS DURING DISASSEMBLY AND ASSEMBLY OF THE SERVO PISTON AND METERING VALVE, AS DUST OR GRIT COULD SCORE THE SERVO CYLINDER ROD OR METERING VALVE SEATING AND NULLIFY RECTIFICATION.

A. Remove the servo piston seal

(1) If the servo piston seal is to be changed with the W.M.C.U. installed on the engine, the additional work, specified in (a) to (e) following, will be required:

(a) Isolate the electrical supplies to the aircraft water/methanol cock and pump.

(b) Detach the cable clip from the bracket on the low torque switch.

(c) Disconnect the fire extinguisher pipe from the connections at the front spray ring and the front of the fireproof bulkhead, detach the clips from the W.M.C.U. and compressor casing and remove the pipe.

(d) Remove the nut and spring washer from the front inner stud on the base of the W.M.C.U., remove the retaining plate and disconnect the drain pipe from the bore in the base of the servo cylinder cover; refit the nut temporarily.

(e) Disconnect the water/methanol supply pipe from the inlet connection on the W.M.C.U.

(2) Unlock the tabwashers and loosen evenly the three nuts securing the inlet connection then, holding the connection firmly against the spring pressure on the metering valve, remove the nuts and withdraw the connection; if necessary, use the extractor HW.15324 to withdraw the connection or, if the tool is not available, fit a suitable hydraulic pipe connection adapter to the threaded union to enable the connection to be levered off.

(3) Extract the circlip from the groove in the metering valve using suitable circlip pliers. Remove the retaining pin and lift the valve head off the servo piston rod taking care not to damage the seating Fit a blanking cover to the connection flange.

(4) Slacken, evenly, the four nuts securing the servo cylinder cover on the base of the W.M.C.U., then hold the cover firmly against the spring pressure, remove the nuts, spring and chamfered washers and remove the cover and spring, taking care that the servo piston does not fall from the cylinder.

(5) Carefully withdraw the servo piston from the cylinder.

NOTE: To ensure cleanliness and that parts are not lost, place all components in a clean container as they are removed.

(6) Using circlip pliers, remove the servo piston seal retaining circlip, then remove the retainer and the seal from the servo piston; discard the seal.

(7) Wash the parts including the metering valve, inlet connection and servo cylinder cover in clean kerosine, then dry off in a moisture-free air blast.

(8) Examine the servo piston rod and the seatings on the metering valve and inlet connection for damage, scoring and pitting.

B. Install the servo piston seal

(1) Fit a new seal to the upper side of the servo piston with the groove in the seal uppermost. Locate the flange of the retainer in the seal groove and secure the assembly to the piston with the circlip.

(2) Remove the blanking covers, carefully insert the servo piston rod into the servo cylinder and through the seal housing in the upper chamber, then slide the servo piston into the cylinder taking care not to damage the lip of the seal.

(3) Support the servo piston rod, locate the metering valve on the end of the rod and fit the securing pin and external circlip, ensuring that the gap in the circlip is at right-angles to the head of the pin.

(4) Fit a new sealing ring to the inlet connection transfer pipe in accordance with the instructions in Chap.89-7, locate the connection on the studs, press the transfer pipe into the bore, and secure the connection with the three tabwashers and nuts; torque load the nuts to 75 lb.in., then bend up the tabwashers.

(5) Ensure that the servo cylinder cover and W.M.C.U. joint faces are clean, then apply the jointing compound, specified in Chap.89-1, in accordance with the instructions in Chap.89-12, taking care not to block the drain passages in the cover and W.M.C.U. casing.

(6) Locate the spring on the base of the servo piston in the cylinder bore, mount the cover on the end of the spring and compress the spring until the cover locates on the studs, ensuring that the servo piston rod locates in the guide on the cover. Fit four chamfered washers, spring washers and nuts, interposing the bonding lead terminal between the spring and chamfered washers on the front outer stud.

(7) Tighten the four nuts evenly to compress the spring until the joint faces meet, then torque load the nuts to 75 lb.in.

(8) If the servo piston seal has been changed with the W.M.C.U. installed on the engine the following additional work will be required:

(a) Connect the water/methanol supply pipe to the connection on the W.M.C.U.

(b) Remove the nut, spring washer and chamfered washer from the servo cylinder cover front inner retaining stud. Fit a new sealing ring to the drain pipe, then fit the drain pipe to the W.M.C.U. Fit the retaining plate to the stud and the drain pipe, fit the chamfered washer, spring washer and nut; torque tighten the retaining nut to 75 lb.in.

(c) Connect the fire extinguisher pipe to the connection on the front spray ring and to the front of the fireproof bulkhead, then secure the retaining clips to the W.M.C.U. and the compressor casing.

(d) Attach the cable clip to the bracket on the low torque switch.

(e) Connect the electrical supply to the aircraft water/methanol cock and pump.

C. Function test the W.M.C.U.

CAUTION: MOVE THE THROTTLE LEVER CAREFULLY DURING THE INITIAL CHECKS ON THE W.M.C.U.

(1) Ground run the engine and carry out the water/methanol system checks as instructed in Chap.71-0, Sub-section 4B, 'GROUND RUN - WET'.

(2) If there is any indication of instability or intermittent operation of the W.M.C.U. while ground running the engine, set the throttle to obtain 14,500 r.p.m., switch off water/methanol, then open the throttle lever slowly and run the engine up to maximum r.p.m. and back to 14,500 r.p.m. six or seven times, taking approximately one minute for each cycle. This process will bed in the new servo piston seal and should eliminate the intermittent operation.

(3) After the checks have been completed, stop the engine, as instructed in Chap.71-0, Sub-section 4B, 'GROUND RUN - WET', then examine the W.M.C.U. for leaks.

Water/methanol control unit - Maintenance practices (cont.)

(6) Refit the drain pipe, the torque meter oil pressure transmitter pipe and the water methanol pipe.

(7) Connect the control rod, and set the water methanol controls as described in Chapter 76-0.

NOTE: If a replacement unit has been fitted, adjust it provisionally by assessment from its nominal setting of 375 p.s.i. to the water/methanol check pressure given on the engine data plate; this initial setting will then prevent excess engine power from being obtained when carrying out the water/methanol check run. The method of adjustment is described later in 'Adjustment/Test'.

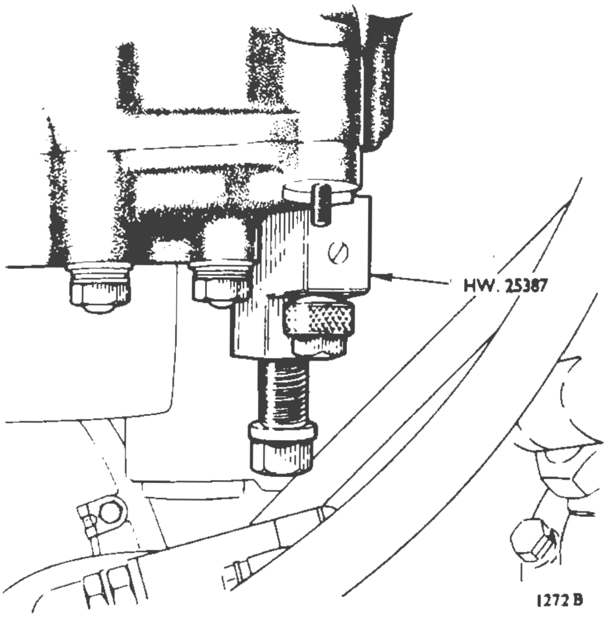
(8) On completion of the first ground run, check the water/methanol unit and pipe connections for leakage.

2. Removal/Installation - oil filter

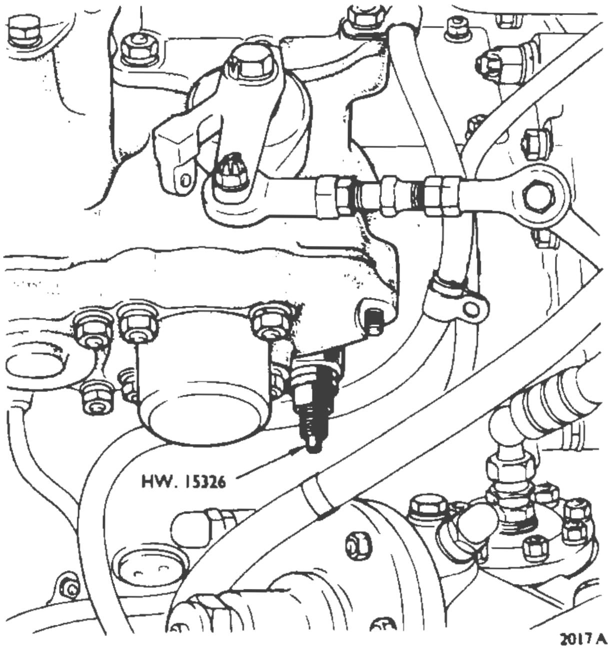
A. Remove the oil filter

(1) Remove the fire extinguishing pipe adjoining the water/methanol control unit, also the harness lead to the oil temperature thermometer, to allow access to the filter.

(2) Remove the nut and bevel washer securing the filter cover to the housing and withdraw the cover, using the extractor HW.25387 as illustrated in fig.202.



Removal of oil filter cover
Fig.202



Removal of oil filter
Fig.203

(3) If the filter remains in the housing, fit the extractor HW.15326 by inserting the centre piece into the filter recess, then tighten the nut on to the tool bush, which locates over the filter housing aperture, to withdraw the filter (fig.203).

B. Install the oil filter

(1) Renew the filter, or carefully clean it in clean kerosine or white spirit, and blow out with compressed air.

(2) Replace the filter in its bore in the casing.

NOTE: If the engine is not to be run immediately, immerse the filter in clean engine oil prior to replacement.

(3) Renew the rubber sealing ring in the filter cover, replace the cover and secure with the nut and bevel washer.

(4) Refit the fire extinguisher pipe.

(5) On completion of the first ground run, check that the filter housing is free from leaks.

3. Adjustment/Test

A. Adjust the water/methanol control unit

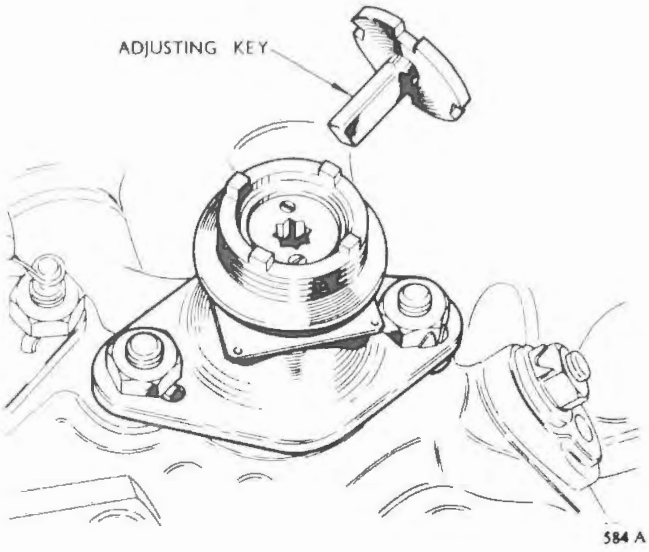
NOTE: Adjust the unit only to restore the water/methanol check pressure recorded on the engine data plate, corrected for prevailing barometric pressure. Do not make indiscrimate adjustments in an endeavour to give additional take-off power. The amount of adjustment required will be determined by the readings obtained during the water/methanol check run.

(1) Remove the domed nut adjacent to the inlet connection and lift the locking device, thus exposed, clear of the castellations, as shown in fig.204.

(2) Using the square shank of the locking device as a key, turn the adjusting piece; turning anti-clockwise increases the rate of injection and, therefore, the controlling torque meter pressure. One eighth of a turn equals approximately 2 p.s.i. torque meter pressure.

NOTE: Adjustment must be made in multiples of one-eighth of a turn to enable the locking plate to engage with the castellations after adjustment; it may be necessary to reposition the locking device in the centre adjustment to obtain correct engagement.

Water/methanol control unit - Maintenance practices (cont.)



Adjustment of water/methanol control unit
Fig.204

(3) Refit and tighten the domed nut and wirelock it to its anchor point.

(4) Ground run the engine and make the water/methanol checks as described in 71-0.

(5) If the range of external adjustment is insufficient to obtain the required torque meter oil pressure, the following adjustment to the unit may be made.

(6) Remove the water/methanol control unit, as described earlier in this section.

(7) Position the unit on a bench, with the main spring cover (fig.205) uppermost.

(8) Remove the five nuts and washers securing the main spring cover; remove the nuts evenly, holding the cover down against the spring-loading. Release the cover carefully.

(9) Lift off the cover and housing, complete with the adjusting washers and spring, leaving the spring carrier and push-rod in position.

NOTE: The spring cover and housing must not be separated or disturbed, as this will involve replacement of the rubber sealing rings.

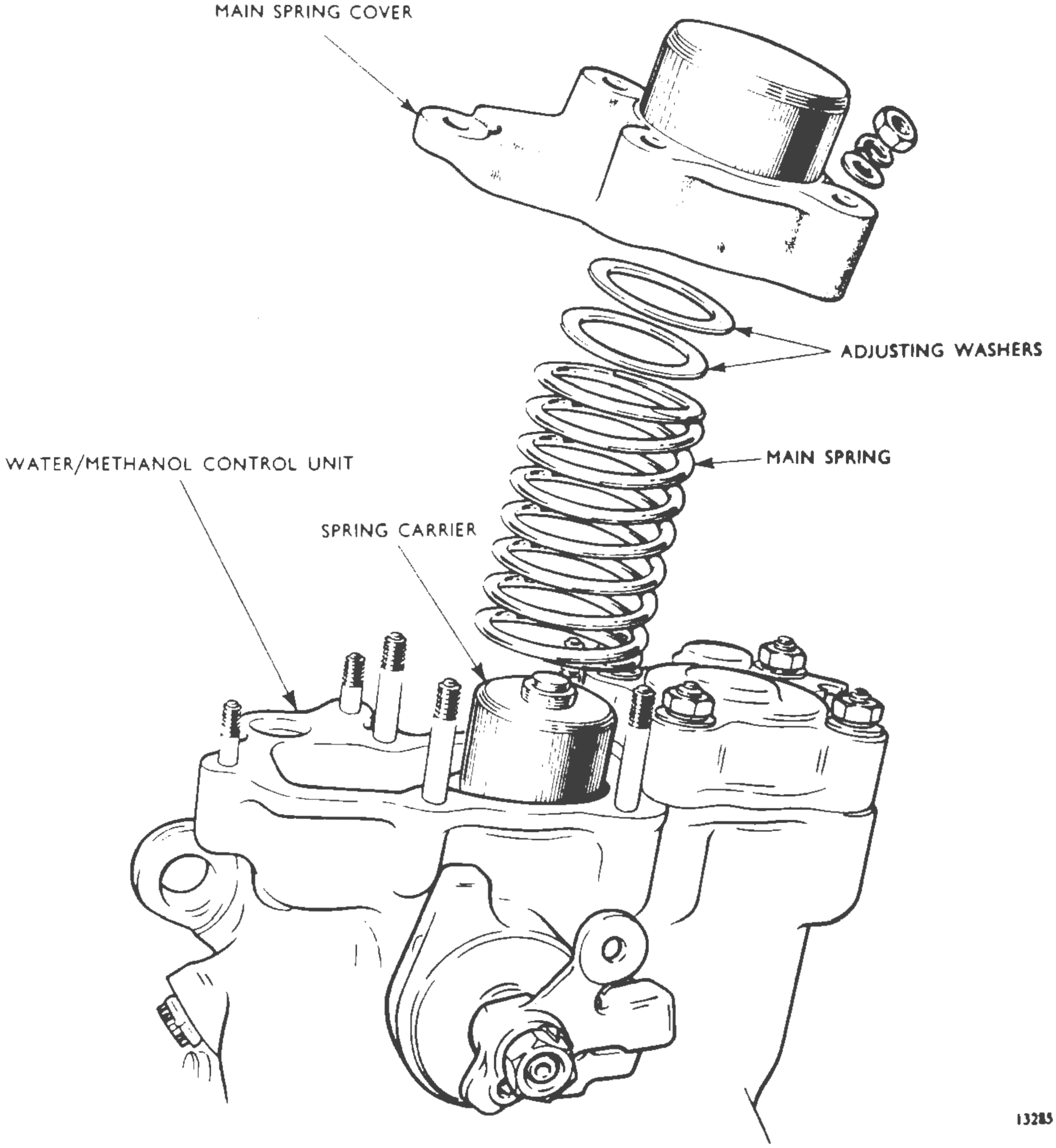
(10) Remove the main spring and adjusting washers (fig.205) from the cover and measure the thickness of the washers fitted. Adjust the washers as follows:

Water/methanol control unit - Maintenance practices (cont.)

(a) If the unit has been rejected through lack of adjustment in the 'screwdown' position i.e. minimum torque too high, select adjusting washers which measure 0.050in. ± 0.01in. thinner than the original washers.

(b) If the unit has been rejected through lack of adjustment in the 'screw up' position i.e. maximum torque too low, select adjusting washers which measure 0.050in. ± 0.01in. thicker than the original washers.

NOTE: Not more than two washers must be fitted to the unit, to give the selected thickness required.



Removal of the main spring adjusting washers
Fig.205

Water/methanol control unit - Maintenance practices (cont.)

(11) Clean the joint face of the main spring cover and its mating face on the casing body, removing any damage marks. Apply a thin coat of jointing compound, specified in 89-1, to both faces.

(12) Fit the selected adjusting washers to the seating on the inside of the cover, then insert the main spring into the cover.

(13) Lower the main spring and cover assembly on to the carrier, ensuring that the conical ends of the push rod are in their locations in the capsule stem and the main spring carrier.

(14) Press down the cover against the loading of the main spring, until the joint faces of the cover and casing meet. Replace the five nuts and washers and tighten them evenly.

(15) Install the water/methanol control unit to the engine, as described earlier in this section.

(16) Ground run the engine and make the water/methanol checks, as described in 71-0.

4. Inspection check

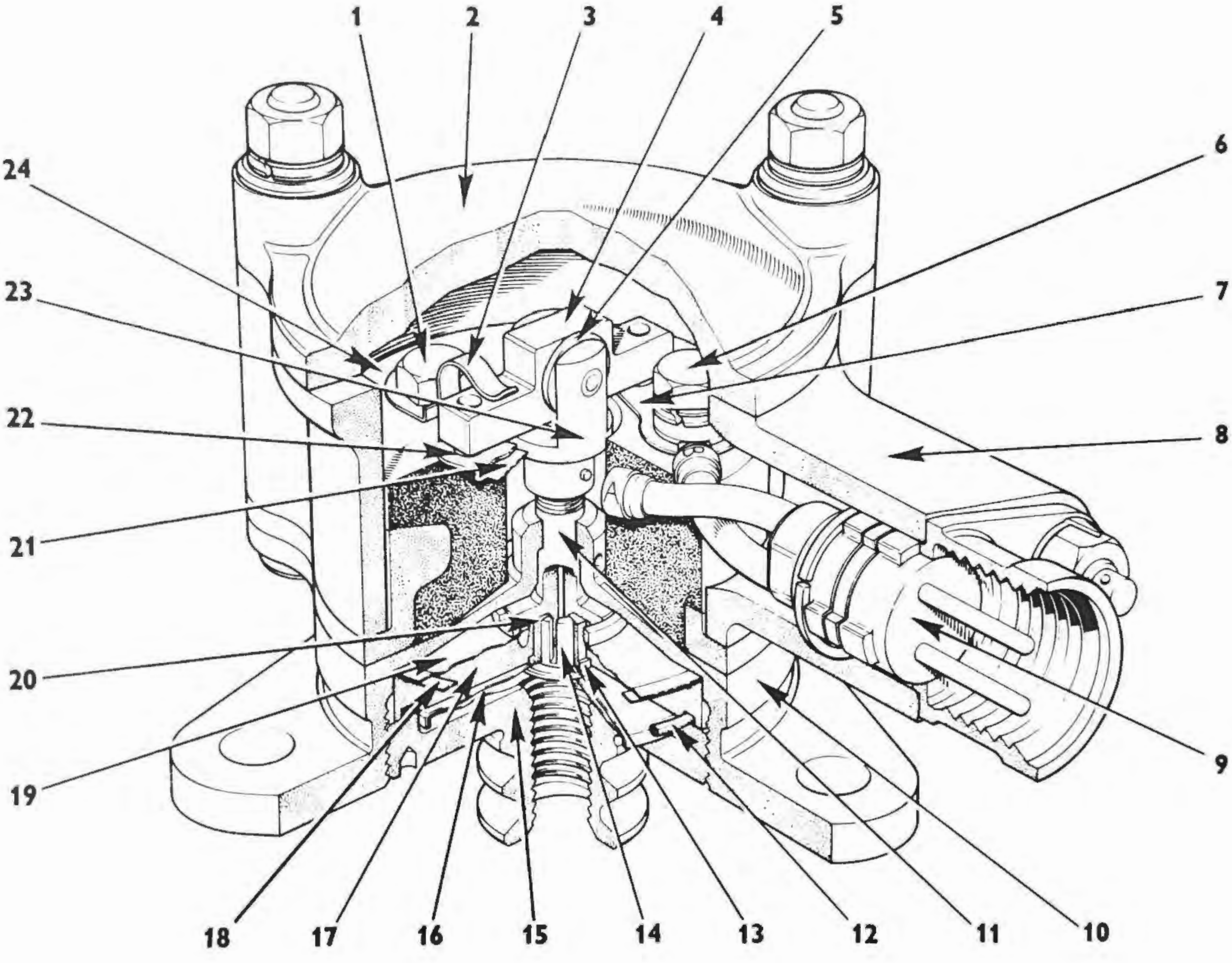
A. Visually examine the water/methanol control unit and pipe connections for security and signs of leakage.

B. Operate the throttle lever in the cockpit and ensure that full and free movement of the control rod and H.P. oil cock lever is obtained throughout the operating range.

LOW TORQUE SWITCH - DESCRIPTION AND OPERATION

1. General

The low torque switch, Fig.1, is mounted on the water/methanol unit and forms part of the propeller auto-feathering system. It is operated by torquemeter oil pressure and closes when engine torque falls below a certain value. This completes the circuit via a switch operated by the throttle lever to the auto-feathering relay which, in turn, energizes the pitch coarsening solenoid in the propeller controller unit and switches on the feathering pump, thus feathering the propeller.



Low torque switch
Fig.1

2. Description (Fig.1)

The primary component of the actuating assembly is a small-volume sensing capsule (16) the top diaphragm of which incorporates a centre piece (13) which is secured to the surface of the diaphragm housing (17). A non-sensing, 'snap action' diaphragm (19) is secured, at its outer flange, to the inner face of the switch base (10) by the diaphragm housing which in turn is secured by a cap (15). The cap provides the pressure connection for torquemeter oil pressure and the chamber between the cap and the diaphragm housing forms a pressure chamber for the sensing capsule. Oil leakage is prevented by a sealing ring (12).

A centre piece (14), secured to the inner face of the sensing capsule, passes through the diaphragm housing and bears on the centre stem (11) which is secured to the snap action diaphragm and passes through the top of the switch base. The 'set' of the snap action diaphragm holds the centre stem against the centre piece. Adjusting washers (18) and (20) are fitted between the snap action diaphragm and switch base and between the centre stem and centre piece respectively.

Secured to the top of the switch base, is an insulating terminal block (24) bored at its centre to accommodate the centre stem; a bridge (4) pivots on a bearing block (23) secured to the centre stem. The bridge is insulated from the bearing block by bushes (5) and carries a contact button (22) at each end. Beneath each button are contact plates (7) secured to the terminal block by setscrews (6). Where necessary, adjusting washers (21) are fitted under the contact plates. Also secured to the terminal block by a setscrew (1) is a leaf spring (3) which retains a button on one side of the bridge permanently in contact with a plate, the button acting as a fulcrum.

The switch components are contained in a housing (8) secured to the switch base and are protected by a cover (2). The housing also forms an electrical receptacle (9) the pins of which are connected internally to the terminal setscrews.

3. Operation

A. Torquemeter oil pressure increasing

Torquemeter oil pressure is sensed by the small-volume capsule and transmitted to the 'snap' action diaphragm. When increasing pressure reaches between 45 and 50 p.s.i. the diaphragm snaps up, carrying with it the centre stem and causing the bridge to pivot and move the free contact button from its plate, thus breaking the circuit through the switch. This movement is limited at approximately 100 p.s.i. by the sensing capsule lower diaphragm being restrained by the top diaphragm centre piece, leaving a contact gap of between 0.015 in. at the break pressure and 0.040 in. at 100 p.s.i.

B. Torquemeter oil pressure decreasing

When torquemeter oil pressure falls to between 45 and 40 p.s.i., the diaphragm snaps down, thus making the bridge contact and completing the circuit through the switch.

LOW TORQUE SWITCH - MAINTENANCE PRACTICES

1. Removal/Installation

CAUTION: ENSURE THAT THE ELECTRICAL SUPPLY TO THE LOW TORQUE SWITCH CIRCUIT IS ISOLATED DURING REMOVAL OR INSTALLATION.

A. Remove switch (Fig.201).

(1) Unlock and disconnect the electrical connection plug from its socket on the switch.

(2) Remove the three setscrews, spring and plain washers from the mounting flange and disconnect the cable clip bracket.

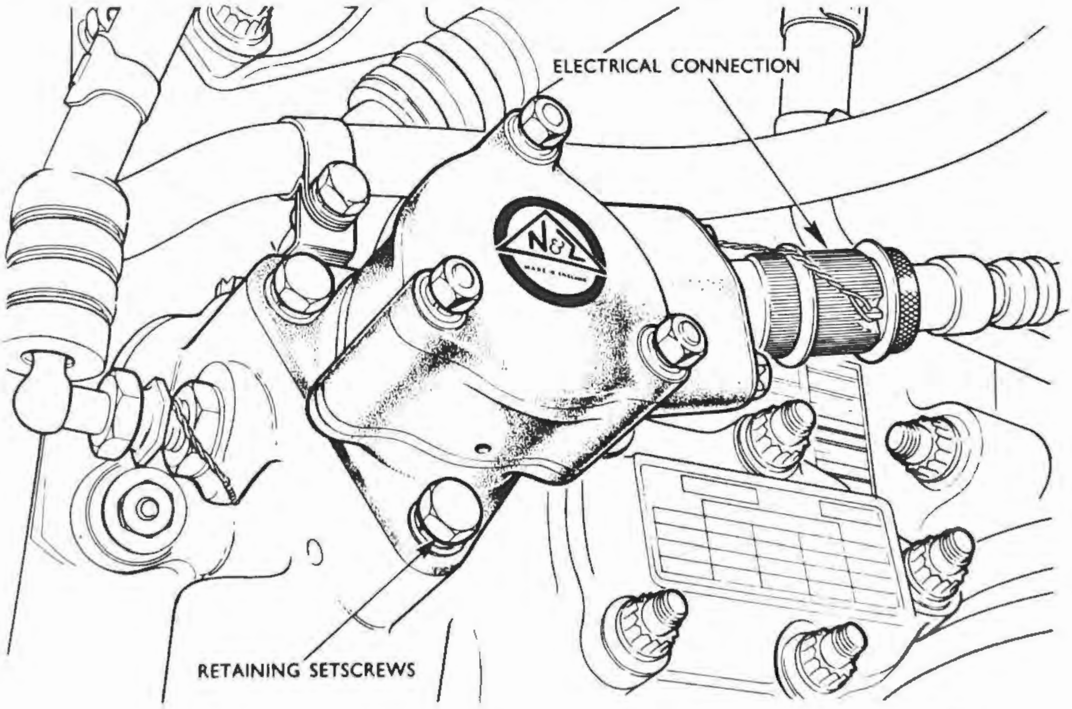
(3) Turn the switch slightly to free the seal and withdraw the switch from the water/methanol unit.

(4) Discard the sealing rings.

B. Install switch

(1) Fit two new rubber sealing rings, as described in 89-7, to the grooves in the pressure connection on the switch.

(2) Insert the pressure connection into its locating bore in the centre of the switch mounting face on the water/methanol unit.



Low torque switch - Removal details
Fig.201

Low torque switch - Maintenance practices (cont.)

(3) Align the holes in the switch securing flange with those in the mounting face.

(4) Locate the clip bracket on the switch, then secure the switch with the three plain and spring washers and setscrews.

(5) Reconnect the electrical plug to the socket on the switch and lock the connection to its anchor point with 0.028 in. wire (89-1).

2. Adjustment/Test

A. Function test low torque switch.

Carry out the auto-coarsening (auto-feathering) circuit checks described in 71-0 or 72-0, 'Adjustment/Test' (Propeller system functional checks - engine stationary), then run the engine and check that the switch operates satisfactorily by opening the throttle fully and checking that the feathering pump warning light does not come on (i.e. switch contacts opening).

B. If required the test described below may be used to check the switch before installation or during trouble shooting.

(1) Check insulation resistance

Using a 500-volt d.c. insulation tester, measure the insulation resistance between each plug pin and earth on the plug shell; resistance between each pin and earth must not be less than 20 megohms.

(2) Continuity check

Connect a suitable lamp and battery across the plug pins and check the continuity of the switch. If the continuity is faulty change the switch.

3. Inspection/Check

(1) Check the switch and the electrical connection for security of attachment, correct locking and freedom from damage.

(2) Visually examine the switch for external seepage of oil; if oil is evident, clean off the oil and ground run the engine (71-0 or 72-0, p.b.501) to confirm leakage from the switch.

Continued on next page

(3) Examine the electrical connection for oil contamination and rectify as necessary.

NOTE: If a Rolls-Royce supplied harness is fitted and oil contamination is found, examine all other connections in the same harness assembly. If oil penetrated to any of these, or if it is suspected oil has reached the main conduit, the harness assembly must be changed.

(4) Function test the switch as described in '2. Adjustment/Test' and check it for serviceability.

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ENGINE DATA

DART 528, 528-7E and 529-7E

Note: The suffix 'D' to the engine mark number denotes a non-standard type of nozzle box is fitted, requiring special handed exhaust units.

TYPE OF ENGINE	Propeller turbine
Main differences	
Dart 528	Basic engine
Dart 528-7E	As Dart 528 but with H.P. turbine blades in improved material, permitting higher Take-off and Max. Continuous T.G.T. limitations
Dart 529-7E	As Dart 528-7E but with a higher Take-off rating, for use in executive aircraft only

Power (static, I.S.A. sea-level, test-bed conditions)

Dart 528 and 528-7E	*Minimum*	1,835 S.H.P. at 15,000 r.p.m. plus 485 lb. thrust
	Average	1,910 S.H.P. at 15,000 r.p.m. plus 505 lb. thrust
Dart 529-7E	*Minimum*	1,910 S.H.P. at 15,000 r.p.m. plus 485 lb. thrust
	Average	1,990 S.H.P. at 15,000 r.p.m. plus 507 lb. thrust

Direction of rotation — propeller	Left-hand tractor
engine	Clockwise viewed from rear
COMPRESSOR	Single entry two-stage centrifugal
Compression ratio (nominal)	5.62 : 1
COMBUSTION CHAMBERS	Seven interconnected straight flow
Numbering	Anti-clockwise viewed from rear, No. 1 elbow at the top
TURBINE	Three-stage, axial flow
PROPELLER	Four bladed, variable pitch
Reduction gear ratio	0.093 : 1
HANDLING DATA	
Maximum diameter	45 in. approx.
Overall length	98 in. approx.
Weight of engine (dry)	1,415 lb. approx.
Centre of gravity	Approx. 2.2 in. aft of centre line of engine feet
FUEL SYSTEM	Variable pressure feed to seven fixed orifice burners
Type of fuel	See 89-1
Fuel pump	Multi-plunger, servo-operated, variable stroke
Flow control unit	Altitude-sensitive unit, with L.P. filter, H.P. cock, throttle valve
Burners	Simplex, single orifice, emitting conical atomized spray

DE-ICING SYSTEM

Air intake	Electrical heating through intermittently and continuously heated elements
Fuel filter	Compressor hot air through solenoid-operated gate valve

WATER METHANOL SYSTEM	Automatic, progressive injection to maintain I.S.A. take-off power at high air temperatures
COOLING AIR SYSTEM	Pressure air from compressor to main bearing seals and turbine
Cooling air outlet temperature	Up to 300°C.

AIRFLOW AND FUEL CONSUMPTION

I.S.A. static sea-level

ENGINE SPEED	APPROX. AIRFLOW	APPROX. FUEL CONSUMPTION					
		Dart 528 rating			Dart 529-7 rating		
r.p.m.	lb./sec.	lb./hr.	gall./hr.		lb./hr.	gall./hr.	
			IMP.	U.S.		IMP.	U.S.
Idling	5	245	31	37	245	31	37
13,000	17.5	1005	127	153	1030	130	157
14,000	20.5	1210	153	184	1235	156	188
14,500	22.5	1310	166	199	1340	170	204
15,000	23.5	1400	177	213	1435	182	218

LUBRICATION SYSTEM	Self-contained, with continuous circulation by one pressure pump and four scavenge pumps
Circulation	Tank — pressure pump — propeller controller, bearings and torque meter—scavenge pumps—oil cooler—tank
Oil specification	See 89-1
Oil consumption	1 Imp. pint (1.2 U.S. pints)/hr. max.
Tank capacity	26.5 Imp. pints (31.8 U.S. pints)
Oil pressure to propeller controller and water/methanol unit	50 to 70 p.s.i. approx.
Oil pressure to bearings, wheelcase, and torque meter	71-0 — Adjustment/test

STARTING SYSTEM	Electric starter motor and high-energy ignition in No. 3 and 7 combustion chambers

CONTROLS

Engine power	Single lever through interconnection of throttle and propeller controller
Engine stopping and manual feathering	H.P. cock control interconnected to feathering selection lever on propeller controller
Engine fuel trimmer	Electric actuator — varies throttle fuel datum relative to propeller controller lever position

INSTRUMENTS

Engine speed	Tachometer generator on accessory gearbox
Turbine gas temperature (T.G.T.)	Twelve thermocouples in intermediate nozzle guide vanes
Oil pressure	Electrical transmitter
Oil temperature	Thermometer in pressure pump inlet
Fuel pressure	See aircraft manufacturer's publications
Torque meter oil pressure	Electrical transmitter

SERVICING AND STORAGE MATERIALS

1. Fuels

A. Approved fuels

Grade (Type)	Specification
Kerosine Type (AVTUR: JP.1)	D.Eng.R.D.2453 Issue 3 Am 1 D.Eng.R.D.2494 Issue 7 Am 1 A.S.T.M. D1655-74 JET A A.S.T.M. D1655-74 JET A-1 3-GP-23h I.A.T.A. Nov.1974: Kerosine type U.S.S.R. TS-1 (GOST 10227-62 Am 1) U.S.S.R. T-7 (GOST 12308-66) Romanian State 3754/73 (CS-3) AIR 3405/C
Wide Cut Fuels (AVTAG: JP.4)	D.Eng.R.D.2454 Issue 3 Am 1 D.Eng.R.D.2486 Issue 8 Am 1 A.S.T.M. D1655-74 JET B I.A.T.A. Nov.1974 JP.4 type 3-GP-22h MIL-T-5624J JP.4 grade AIR 3407/B TL 9130-006 Issue 4 (German)
High Flash Point (AVCAT: JP.5)	D.Eng.R.D.2498 Issue 6 3-GP-24g MIL-T-5624J JP.5 grade AIR 3404/B TL 9130-007 Issue 4

NOTE: 1. Fuel Specification D.Eng.R.D.2453 and D.Eng.R.D.2454 already include Hitec E515 (formerly Santolene C) and anti-icing additive to Specification D.Eng.R.D.2451 (Issue 2 or later issue) to approved limitations.

2. If the fuel pump engine overspeed governor has been set using wide-cut fuel, it must be reset when the fuel is changed to Kerosine (higher specific gravity).

B. Approved deviations

Fuels with the following deviations from Specification D.Eng.R.D.2494 are acceptable e.g. U.S.S.R. TS-1 (GOST-10227-62 Am 1).

Flash point - Minimum 21 deg.C. (70 deg.F.)
Mercaptan sulphur - Maximum 0.005 per cent by weight

Servicing and storage materials (cont.)

C. Optional additives

The following additives (additional to those included in the above D.Eng. R.D. Specifications) are approved by Rolls-Royce Limited, subject to the limitations stated:

(1) Corrosion inhibitor/lubricity aids

Additive	Concentration Range - lb/35000 Imp.Gallons(mg/l) Minimum	Maximum
Hitec E515	4 (11 mg/l)	7.5 (21 mg/l)
Apollo PRI19	3 (9 mg/l)	8 (23 mg/l)
Tolad	7.5 (21 mg/l)	12 (34 mg/l)
Emery 9855	4.5 (13 mg/l)	12 (34 mg/l)
Du Pont DCI-4A	3 (9 mg/l)	8 (23 mg/l)
Hitec E580	3 (9 mg/l)	8 (23 mg/l)

NOTE: The minimum requirement is to ensure that sufficient additive is available when it is required to act as a lubricity aid.

(2) Anti-icing additives - Max. concentration 0.15 per cent by volume

(a) D.Eng.R.D.2451 (Issue 2)

* (b) D.Eng.R.D.2451 (Issue 1) or any equivalent

(c) MIL-I-27686E

* It is preferred that additive (b) is not used.

(3) Anti-microbiological additives

(a) Methyl Cellosolve may be used on a continuous or intermittent basis. Whenever this additive is used it is permissible to burn off the treated fuel in the engine always provided it is diluted such that the concentration of methyl cellosolve does not exceed 0.15 per cent by volume and that it is not contaminated with microbiological debris.

Servicing and storage materials (cont.)

(b) Biobor JF may be used at concentrations not exceeding 270 parts per million (p.p.m.) (total Boron content not to exceed 20 p.p.m.), on a non-continuous basis. Whenever this additive is used, it is permissible to burn off the treated fuel in the engine always provided it is diluted such that the concentration of Biobor JF does not exceed 270 parts per million, (total Boron content not to exceed 20 p.p.m.) and that it is not contaminated with microbiological debris. When it is necessary to continue preventative treatment by continuous usage of Biobor JF, it is recommended that the concentration should not exceed 135 p.p.m. (total Boron content not to exceed 10 p.p.m.) and that this should be achieved by pre-mixing in storage and not by direct addition to the aircraft tanks.

Under certain conditions solid matter may be precipitated from fuel containing this additive during flight, therefore a careful watch should be kept on the fuel differential pressure signals in flight immediately following its use in the aircraft tanks.

NOTE: The engine low pressure fuel filter must be renewed at the time of initial preventative treatment with Biobor JF and renewed again after 50 hours flying, with further samples at 300 hours intervals to re-establish the filter life. If it becomes necessary to again manually clean the aircraft fuel tanks, filters should be changed immediately and again after 50 hours to ensure no debris is present.

(c) Take care that only Biobor JF is used.

(4) Anti-static additive - Shell A.S.A.3

In concentrations not exceeding 1.0 part per million.

2. Mixing of fuels

A. Mixing of approved fuels is permissible subject to any limitations in the Flight Manual.

3. Wide-cut fuel

A. The use of wide-cut fuel is approved subject to any limitations in the flight or appropriate aircraft manuals. However, this may result in a reduction of high pressure fuel pump life.

Servicing and storage materials (cont.)

4. Specification of water/methanol

Rolls-Royce Specification AEP-1-W/M, Issue 6 (see Chapter 89-10 for the complete specification).

5. Engine lubricating oils

A. 5 Centistoke

* Texaco Synthetic Aviation Turbine Oil 7730
* Texaco Starjet 5

* Dowty/Rotol agreement required before using these oils.

B. 7.5 Centistoke

Only the following brands of oil to specification D.Eng.R.D.2487 are approved:

AeroShell Turbine Oil 750

Castrol 98 Gas Turbine Oil

Castrol 98 U.K. Synthetic Aviation Oil (Castrol 98 U.K.)

Esso/Exxon Turbo Oil 274

Texaco Synthetic Aircraft Turbine Oil 35 (T.S.A.T.O.35)
also marketed as:

Caltex Synthetic Turbo Oil 35

6. Reclamation of oil

Oils of the above brands, when reclaimed to the approved Rolls-Royce standards for the appropriate viscosity grade, are approved for use.

7. Mixing of oils

It is desirable to keep to one brand of oil but approved brands may be mixed if operationally essential.

8. Maintenance and storage materials

MATERIAL	APPLICATION	SPECIFICATION		APPROVED BRANDS
		BRITISH	AMERICAN	
Greases	Control box ball ends and cross-shafts	D.T.D.5598	MIL-G-23827A	(B.P. Aero 31 (Mobil 22 (Aeroshell No.7 (Esso 5114 E.P.
	Alternative for oil system sealing rings	D.T.D.900/4841	MIL-G-25760A	Aeroshell 16
Silicone rubber lubricant	Silicone rubber sealing rings in contact with air	D.T.D.900/4298	MIL-I-8660	Midland Silicones MS.4 Dow Corning DC.4
Anti-seize compounds	Assembly of combustion chamber to nozzle box	D.T.D.392A	MIL-T-5544A (ASG)	
	Hot air valve (pre-Mod.664) and fuel heater air transfer tube connections			
	Lubricating screw threads in hot areas of engine			
	Lubrication of engine mount spherical bushes	D.T.D.5530		Silkolene 751
Liquid paraffin (Technical grade)	Assembly of sealing rings in fuel system			
Penetrating oil	Easing withdrawal of front cover dowels			Freeway Lusol
Petroleum jelly	Initial lubrication of ball and roller bearings	DEF.2333 Grade PX-7		

Servicing and storage materials (cont.)

8. Maintenance and storage materials (cont.)

MATERIAL	APPLICATION	SPECIFICATION		APPROVED BRANDS
		BRITISH	AMERICAN	
Jointing compounds	Igniter plugs Discharge nozzle/ nozzle box sealing face	D.T.D.900/4344		Silkolene Grade 762
	Reduction gear front cover Expansion chamber/ air casing joint Oil relief valve flange Water methanol control unit servo cylinder cover faces	D.T.D.900/ 4586A		(Hylomar (Light) (SQ.32/L
	Combustion chamber spherical joint rings Fuel drain valve Propeller shaft seal retaining setscrews	D.T.D.900/ 4586A		(Hylomar (Medium) (SQ.32/M
Solvents Benzine or Xylene	Removing jointing compound	B.S.458B		
Solvent	Cleaning fuel burners			LIX 400 TURCO 5884 Butyl Cellusolve

Servicing and storage materials (cont.)

8. Maintenance and storage materials (cont.)

MATERIAL	APPLICATION	SPECIFICATION		APPROVED BRANDS
		BRITISH	AMERICAN	
Trichloroethylene	Degreasing joint faces, cross-shafts and air casings	Triklone 'N' B.S.580: 1963	Fed. Spec. 1956 O-T-634a Type 2	
Inhibiting fluids	Propeller shaft and accessory gear box drive flange	DEF.2181A	MIL-C-6529C (Type 2)	
	Fuel system and fuel operating units	DEF.2001A or D.Eng.R.D.2490	MIL-O-6081B(ASG) Grade 1010	
	External engine protection	DEF.2331A	MIL-C-16173C Grade 2	
Selenious acid	Reprotection of magnesium castings			
Air drying primer-Red	Damaged areas of stoving enamel as undercoating	R.R. Spec. MS.606		Kearsley's Spec. Co.5151
Air drying enamel-Grey	For touching up damaged areas of stoving enamel			Kearsley's Spec. Co.5153
Air drying high heat resisting enamel	For touching up damaged areas of aluminium enamel	R.R. Spec. MS.614		Kearsley's Spec. E.2725/R2/Clear and E.2725/R2/metallic paste

Servicing and storage materials (cont.)

8. Maintenance and storage materials (cont.)

MATERIAL	APPLICATION	SPECIFICATION		APPROVED BRANDS
		BRITISH	AMERICAN	
Protective coating	Treat damaged areas of air casing protective coating			Sermetal 'W'
Corrosion resistant touch-up coating	Restore damaged areas of air casing protective coating	PL.177 PJP 3971.A. 8000	MIL-C-81751	
Turbo cleaning fluid concentrate	For washing engine internally	R.R.Spec.MS.624 (formerly Sq.25)		Turbex Turco 4217 Ardrox 624
Lignocellulose grit	Cleaning engine internally		MIL-G-5634B Type 1	14/25 Turco Softblast (U.K.) Turco Carboblast (U.S.)
White spirit	Engine external cleaning	BS.245		
Desiccant (Silica gel)	Engine packing	BS.2540	MIL-D-3464	

Servicing and storage materials (cont.)

8. Maintenance and storage materials (cont.)

MATERIAL	APPLICATION	SPECIFICATION		APPROVED BRANDS
		BRITISH	AMERICAN	
Paper-humidity indicator	Engine packing	DEF.1296		
Paper-degrease resisting (6 ft. x 3 ft. sheets)		CS.2193D		
Polyvinyl chloride (P.V.C.) film (6 ft. x 3 ft. sheets)	Engine packing alternative to grease resisting paper	BS.1763 (Type 1) (Plain)		
* Glass cloth/P.V.C. or Terylene/P.V.C. laminate	Repair of storage bags			Plastoglass 684 or Plastolene 954
* Adhesive				Holdtite 3445
* Talc				
* French chalk (Technical Grade)				
P.V.C. self-adhesive tape	Temporary repair of storage bags	U.K./AID/909/1		
Acetone	Repair of storage bags	BS.509	Federal Spec. O-A-51	
Stainless steel lockwire		D.T.D.189 22 S.W.G. (0.028 in.)		
† V.P.I./C.H.C. paper	Protection against corrosion	R.R. Spec. MS.644		

NOTE: * Small quantities of these materials are included in transportation repair kit C.P.2849, (Plastoglass) or C.P.3093/4 (Plastolene), obtainable from Rolls-Royce Ltd.

† Store the paper in a P.V.C. bag and unroll the quantity required for immediate use only.

Servicing and storage materials (cont.)

8. Maintenance and storage materials (cont.)

MATERIAL	APPLICATION	SPECIFICATION		APPROVED BRANDS
		BRITISH	AMERICAN	
Water-proof abrasive paper	Blend damaged areas of air casing protective coating	Grade grit size 320 or 240		
Abrasive paper (finest grade)	Prepare air intake nose cowling for repair			
Benzene (not Benzine) or Naphtha				
Rubber coating compound	For minor repairs to air intake nose cowl anti-icing element rubber covering			Adcora P6 Boscoprene 2114-5 Part 1 and Part 2
Adhesive				Bostik 1777
Primer	Application of compound to combustion chamber drain tubes in accordance with Mod.1632			DC.4094 MS.2402
Sealing compound				Silastic RTV.731
Primer				Silcoset O.P.1
Silicone compound				Silcoset 151
Silicone compound				Silcoset 152
Silicone compound				RTV106

Servicing and storage materials (cont.)

8. Maintenance and storage materials (cont.)

MATERIAL	APPLICATION	SPECIFICATION		APPROVED BRANDS
		BRITISH	AMERICAN	
Pencil/crayon - temporary/marker	Marking of components			Verithin. Staedler Mars Omnichrome.
Felt or fibre - temporary marker				KOH-I-DRY. Soft chalk.
Lay-out fluid				Marlube Sq 9B.
Marking ink				Ardrox 386. American black
Electrolyte				EM 16A

Servicing and storage materials (cont.)

9. Manufacturers and suppliers

Turco Products Inc., 6135, South Central Avenue, Los Angeles 1, California, U.S.A.	Carboblast Turco 4217
Turco Chemical Products Ltd., Victoria Road, Southborough, Tunbridge Wells, Kent, England.	Softblast
Med-Lab Limited, 2-6 Agard Street, Derby, England.	Hylomar Benzene Turbex Silkolene 751 Silkolene Grade 762 V.P.I./C.H.C. paper Bostick 1777 Boscoprene 2114-5 Adcora P6 Benzine. Xylene Sermetal 'W' Trichloroethylene Lusol. Freeway Verithin Pencil/Crayon Staedler Mars Omnichrome KOH-I-DRY Soft chalk Marlube Sq 9B Ardrox 386 American black
Rolls-Royce (Canada) Ltd., P.O. Box 1000, Montreal, Canada.	Silkolene Grade 762
Pinchin Johnson Paints, Transport Division, Rotton Park Street, Ladywood, P.O. Box 359, Birmingham 16.	Primers and enamels Corrosion resistant touch-up coating

Servicing and storage materials (cont.)

U.S.M. Corporation, 784 Memorial Drive, Cambridge 39, Massachusetts, U.S.A.	Boscoprene 2114-5 Bostick 1777
Bostick Limited, Lower Middleton Street, Ilkeston, Derby, England	
Brand Packaging Ltd., Bridge Mills, Pendleton, Manchester, N6 6EL England.	Desiccant
Dow Corning Corporation, P.O. Box 592, Midland, Michigan.	Silicone Compound DC.4
Midland Silicones Ltd., 68, Knightsbridge, London W.I. England.	Silicone Compound MS.4
Surridge's Patents Ltd., Croydon Road, Beckenham, Kent, England.	Holdtite 3445
United States Borax and Chemical Corporation, Los Angeles, California, U.S.A.	Biobor JF
Shell Oil Co., Shell Aviation Dept., 50w, 50th Street, New York 20, New York, U.S.A.	Petroleum jelly
Shell Oil Co., Houston, Texas, U.S.A.	

Servicing and storage materials (cont.)

Esso Petroleum Co. Ltd., Esso House, 76-118 Victoria Street, London S.W.1. Med-Lab Limited, 2-6 Agard Street, Derby, England.	Petroleum jelly
Turco Chemical Products Ltd., The Brillo Group Headquarters, Cord Wallis Estate, Maidenhead, Berkshire, U.K.	Turco 5884
The Lix Corporation of Missouri, 2808 East 85th Street, Kansas City, Missouri 64132, U.S.A.	LIX 400
Teleflex Inc., Sermetal Division, Dickenson Road & Wissahickson Avenue, North Wales, Pennsylvania 19454, U.S.A.	Sermetal 'W'
International Paint Coy., Inc., 21 West Street, New York, New York City 1006, U.S.A.	Corrosion resistant touch-up coating
Eagle Pencil Co. Ltd., Ashley Road, London N17	Verithin - pencil/crayon - temporary marker
Staedler (U.K.) Ltd., Cowbridge Road, Talbot Road, Pontyclum, Glamorgan CF7 8ZZ	Staedler Mars Omnichrome - pencil/crayon - temporary marker

Servicing and storage materials (cont.)

Berol Ltd., Oldmeadow Road, Kings Lynn, Norfolk	KOH-I-DRY - felt or fibre - temporary marker
General Engineering Supplies Co. Ltd., 554 High Road, Leyonstone E11	Soft chalk - temporary marker
Marston Lubricants Ltd., 7-11 Naylor Street, Liverpool L3 6DS	Marlube Sq 9B - Lay-out fluid
Ardrox Ltd., 74 Furlong Road, Bourne End, Bucks. Ardrox Ltd., P.O. Box 814, St. Catherines, Ontario 62R 6YR Canada.	Ardrox 386 - Marking ink
Marken U.S.A.	American black - Marking ink
Rolls-Royce Limited, Derby. Electromark (G.B.) Ltd. Harlequin Avenue, Gt. West Road, Brentford, Middlesex.	Electrolyte - EM 16A

RECORDING AND CONTROL OF THE LIVES OF GROUP 'A' PARTS

Group 'A' parts comprise those major rotating parts of an engine the failure of which could, if uncontained, affect the airworthiness of the aircraft. They are therefore subject to life limitations which are mandatory and therefore must not be exceeded in service (see Chapter 5, 'Time Limits'). It must be emphasized that whilst limitations are established and issued by Rolls-Royce, responsibility for controlling the lives of group 'A' parts in service rests with the operator.

The making by Rolls-Royce of a recommendation of the life of a part does not imply that any particular part will achieve this life and it does not constitute a warranty on the part of Rolls-Royce. The appropriate warranty arrangements made between Rolls-Royce and the operator will govern the relationship between the parties.

The lives of the parts are expressed in terms of 'flights' wherever practicable. This is the most direct and accurate way of controlling the service life of parts which are primarily affected by cyclic stresses, because variations in stage lengths are taken into account automatically by this means.

The effects of flight patterns on cumulative cyclic life usage on these parts are derived from a knowledge of the average or datum flight profile flown by the engine; refer to Fig.1.

The shaded bands in the graph (Fig.1) indicate engine speed ranges within which a speed would be selected for a particular operating condition; they are not intended to represent fluctuations of engine speed.

While few variations from the datum flight profile are anticipated in the case of the Dart, where the control characteristic permits changes in engine power without alterations of engine speed, any differences between this datum flight profile and the average profile flown on normal operations could affect the rate of the cyclic life usage. It is therefore in the operator's own interests that such differences should be disclosed to Rolls-Royce for consideration. A particular example would be a flight containing one landing preceded by a series of intentional overshoots required for airfield calibration checks.

Operators who are registered in the UK or who otherwise operate under the regulations of the United Kingdom Civil Aviation Authority (C A A) should note that, for engine mark(s) covered by this manual, the flight profile monitoring requirements of Airworthiness Notice No.44 issue 4 will be satisfied in full by the annual reporting procedure detailed in paragraph 8 b of the Notice.

This applies to new as well as existing operators of these engine marks.

Recording and control of the lives of group 'A' parts (cont.)

The number of 'flights' completed by each part is equal to the number of landings, plus half a 'flight' for each 'touch and go' recorded on the aircraft for the periods during which the engine was installed. A 'touch and go' will comprise any case where a 'wheels on' landing is made and where the engine speed does not fall below 10,000 r.p.m. before power is increased for Take-off.

There are certain parts which are influenced as much by the total hours they are in service as by the number of flights they complete. In such cases, the lives are expressed in flights and hours, whichever is completed first being the limiting factor.

The operator is required to provide Rolls-Royce on a monthly basis with the total flying hours and total landings on each aircraft in his fleet. A standard form entitled 'Monthly Log of Aircraft Total Hours and Landings' should be used for this purpose. It is important that hours and landings should be expressed numerically and not in life code letters. This information is required for two main purposes. Firstly, to enable Rolls-Royce to assess the operator's future life clearance requirements for group 'A' parts. Secondly, to monitor the spare parts provisioning programmes needed to maintain a satisfactory service to the operator.

When engines are sent from service for overhaul, operators should advise the overhaul facility of the following:

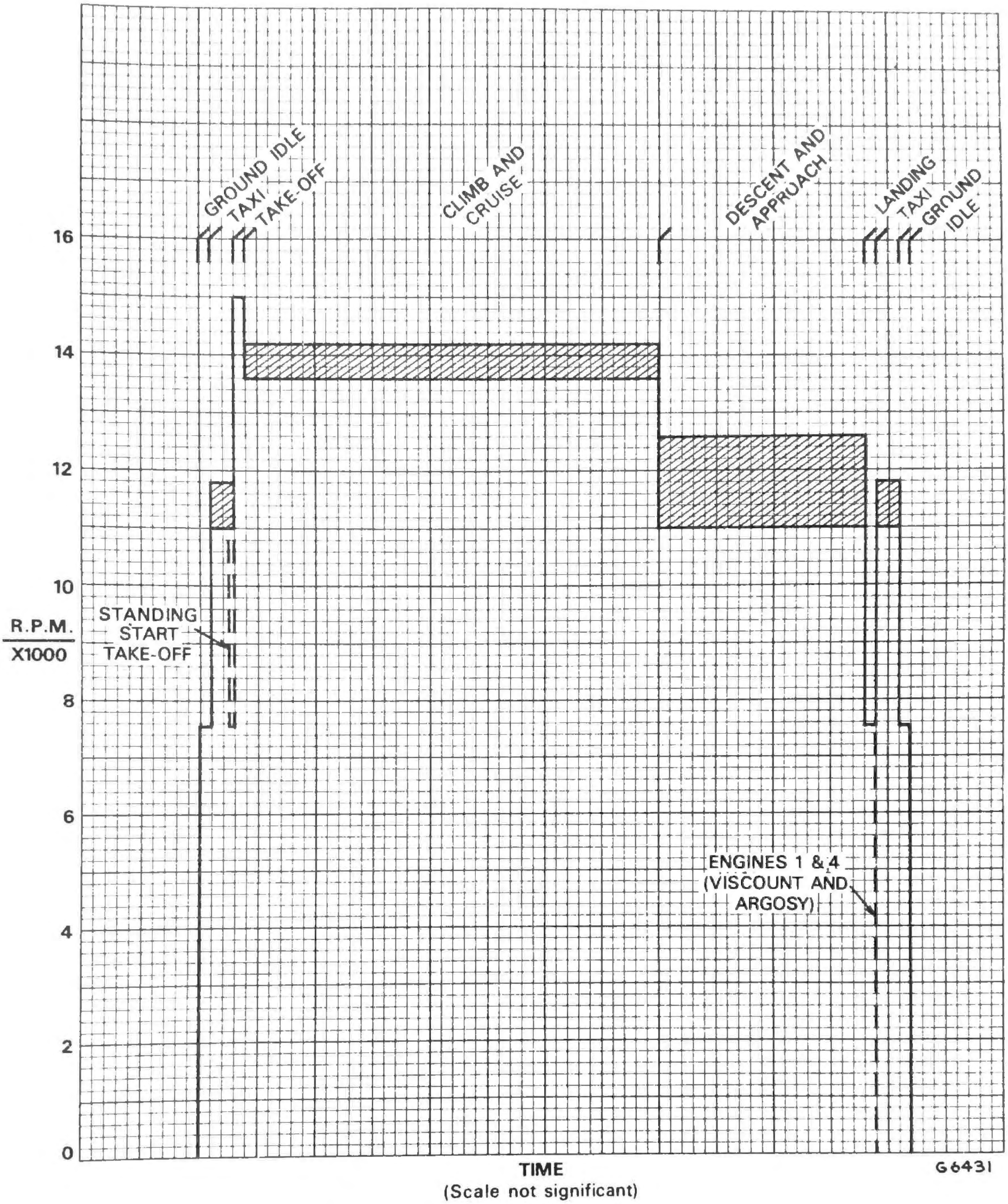
(1) The number of flights and hours achieved by any one engine since its last shop visit.

(2) The minimum number of flights and hours for which engines must be cleared before return.

(3) The group 'A' parts that have been changed in service.

Engines received from the overhaul base will be accompanied with the serial numbers and life completed in flights and hours on those group 'A' parts which have been fitted to engines during shop visits.

Recording and control of the lives of group 'A' parts (cont.)



Datum flight profile - Mk.528, 529 and 532 engines and variants
Fig.1

TORQUE TIGHTENING TECHNIQUE

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TORQUE TIGHTENING TECHNIQUE

1. General

A. A predetermined torque load is applied to nuts, bolts and setscrews to prevent overstressing and to provide optimum security. During assembling of the parts and assembling of the complete engine, nuts, bolts and setscrews must be tightened to either a special load for a particular application or to a standard load for the size of screw thread used. Tables of standard torque loads are given at the end of this section. The parts to be torque tightened to special loads are listed in the appendix to this section. Parts for which no special load is specified in the appendix should be tightened to the standard loads listed in the tables.

B. Use clean engine oil, Item 1011, for lubricating screw threads and abutment faces unless otherwise instructed.

C. Whenever it becomes necessary to retighten nuts, remove the nuts then clean and lubricate the threads before refitting the nuts and retightening to the specified torque load.

CAUTION: FAILURE TO CARRY OUT THE ABOVE INSTRUCTION COULD RESULT EITHER IN AN INADEQUATE CLAMPING LOAD OR, IF THE CORRECT TORQUE LOAD IS EXCEEDED IN AN ATTEMPT TO INCREASE THE CLAMPING LOAD, IN DAMAGE TO THE THREADS WHICH MAY NOT BE OBVIOUS AT THE TIME BUT WHICH MAY CAUSE FAILURE OF THE JOINT DURING SERVICE.

D. Preliminary smoothing of threads and mating faces

NOTE: This need only be carried out where torque loads in excess of 250 lb.ft. are to be applied.

(1) Lubricate the threads and mating faces of the nut and washer with clean engine oil, Item 1011, unless otherwise instructed.

(2) Tighten the nut until approximately half the recommended torque load value is obtained.

(3) Slacken the nut then re-tighten until the full torque load value is reached.

Torque tightening technique (cont.)

E. Where locking plates, tabwashers or split pins (cotter pins) are used as locking devices observe the following:

(1) If a single torque load value is specified, then it is permissible, and in many instances, necessary, to exceed the prescribed torque load value by continuing to tighten the nut until the next locking position is reached.

CAUTION: DO NOT SLACKEN THE NUT TO OBTAIN THE LOCKING POSITION.

(2) If a minimum and a maximum torque load value are quoted, the final torque load value applied must be within the prescribed range.

CAUTION: FAILURE TO COMPLY WITH THESE INSTRUCTIONS MAY RESULT IN FAILURE OF THE UNIT OR ENGINE.

F. When using jointing compound on a joint face which is to be torque loaded, re-check the torque load and re-tighten the nuts, bolts or setscrews, if necessary, after a delay of at least 10 minutes.

G. Shrouded tab washers are prone to 'dishing' during manufacture and, with a single torque tightening application, the washers do not always flatten satisfactorily. Therefore, where shrouded tab washers are used, effect a double tightening procedure, as follows:

(1) Lubricate the screw threads and mating faces with clean engine oil, Item 1011, unless otherwise instructed.

(2) Tighten the nut to the full torque load.

(3) Slacken the nut then re-tighten until the full torque load value is obtained.

Torque tightening technique (cont.)

2. Hand torque wrenches

A. Flexible beam type

(1) To obtain a correct reading, the handle should be gripped lightly with one hand. As the pull must be applied at right angles (90 degrees) to the centre line of the wrench, the handle should float on the pivot-point thus concentrating the force or load at the correct point, refer to fig.1. The position of the hand should not be altered so as to change the concentration of the force from the pivot-point to any other position on the handle. The following tables list flexible beam type torque wrenches and their torque load ranges:

FLEXIBLE BEAM TORQUE WRENCHES

Table 1 - lb.in. range

Load range lb.in.	Rolls-Royce tool number	Size of drive
0-50	1703079	7/32 in. hexagon
40-200	1703080	9/32 in. hexagon
150-600	1703081	3/8 in. square

Table 2 - lb.ft. range

Load range lb.ft.	Rolls-Royce tool number	Size of drive
40-150	3403424	1/2 in. square
100-300	3403426	3/4 in. square

(2) To ensure the greatest possible accuracy in reading the scale values, choose a torque wrench which, when in use, will register within the higher range of the scale. The first quarter of the scale must not be used for mandatory loads. This is because the accuracy with which small loads can be read at the beginning of the scale is not considered adequate, and, wherever possible, a wrench should be selected where full benefit would be obtained from the scale provided. Some flexible beam torque wrenches may have the 'unacceptable' part of the scale blank.

B. Inspection of wrenches in service

(1) Check, under conditions of no load, that the torque indicating pointer intersects the zero mark on the scale; if not, then adjust as instructed in the torque wrench manufacturer's instruction book.

3. Adapters

A. Adapters for torque wrenches are available as follows:

Table 3

ADAPTERS FOR TORQUE WRENCHES

Rolls-Royce tool No.	Adapter size		Application
	input	output	
KU12951A	7/32 in. hexagon	9/32 in. square	To enable socket spanners (input size 9/32 in. sq.) to be used with wrench 1703079 (driving tang size 7/32 in.hex.)
KU12952A	7/32 in. hexagon	3/8 in. square	To enable extension spanners (input size 3/8 in.sq.) to be used with wrench 1703079 (driving tang size 7/32 in.hex.)
AK137	9/32 in. square	3/8 in. square	To enable socket spanners (input size 3/8 in. sq.) and/or entension spanners (input size 3/8 in.sq.) to be used with wrench 1703080 (driving tang size 9/32 in.sq.)

4. Extension spanners

A. Use of an extension spanner has the effect of increasing the leverage of the torque wrench, therefore if the scale reading is not corrected to suit the length of extension used, then the nut or bolt would be over-tightened with possible serious results.

Torque tightening technique (cont.)

B. To obtain true readings when using an extension spanner:

(1) Grip the wrench handle as previously described and keep the extension spanner in line with the wrench (fig.1).

(2) Correct the wrench scale reading in accordance with the following formula:

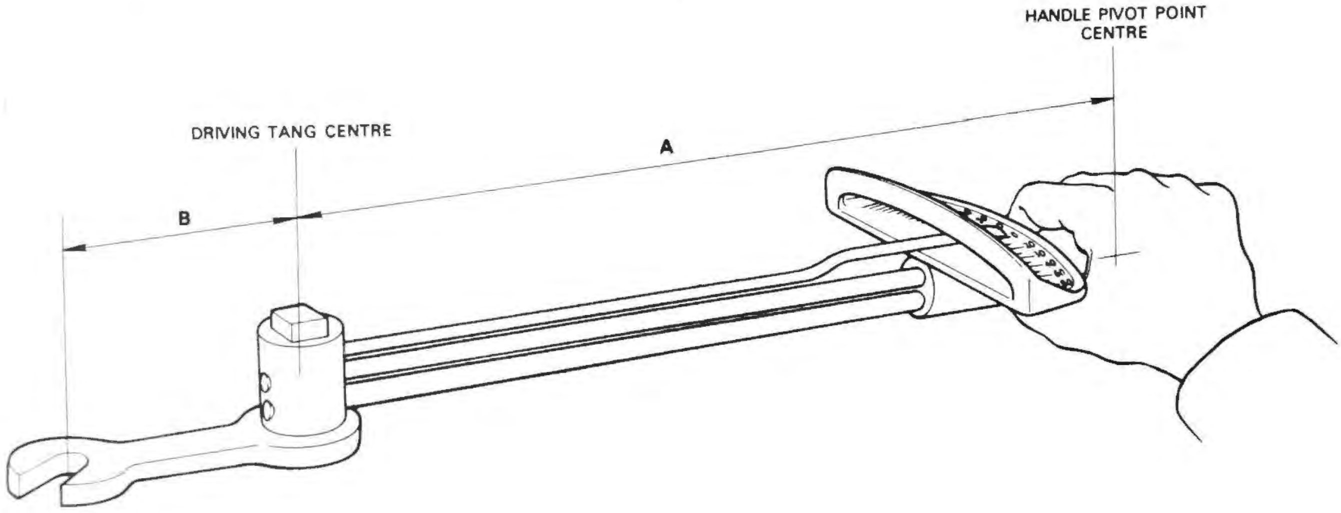
Indicated scale reading

$$= \frac{\text{required torque x length of wrench lever (A)}}{\text{length of wrench lever (A) + length of extension spanner (B)}}$$

Example:

An 0.250 in. diameter nut is to be tightened by a 10 in. torque wrench using a 3 in. extension spanner. The actual torque load required is 75 lb.in. at the nut. Then, using the formula:

$$\text{Indicated scale reading} = \frac{75 \times 10}{10 + 3} = \frac{750}{13} = 58 \text{ lb.in.}$$



Correct method of using extension spanner with torque wrench
Fig.1

5. Reduction gearboxes

   A. Reduction gearboxes may be fitted to torque wrenches when the torque load required is greater than the normal maximum of the wrench, and the torque wrench reading corrected to compensate for the reduction gear ratio.

6. Power wrenches

   A. Power wrenching must only be used for preliminary tightening of nuts and bolts. The power wrench must be set to give 50 per cent of the final torque load and the final torque applied by use of the approved hand torque wrench.

7. Fitting studs

   A. Apply the standard torque loads listed in table 4 unless special torque loads are specified elsewhere.

8. Fitting serrated head sealing plugs (Unified or Whitworth threads)

   A. Apply the torque loads listed in table 5 to both Unified and Whitworth thread sealing plugs fitted into either aluminium or magnesium unless special values are specified elsewhere.

   B. Do not overtighten sealing plugs beyond the recommended torque load value to cure a leak. If necessary, fit a new sealing plug and/or recondition the plug seating.

9. Fitting non self-locking nuts to studs or bolts; also fitting bolts, used as setscrews, in non self-locking thread holes

   A. Apply the standard torque loads listed in table 6 unless special torque loads are specified elsewhere.

10. Fitting self-locking nuts to studs and bolts; also fitting bolts, used as setscrews, in self-locking wire thread inserts or in self-locking thread captive nuts

    A. Apply the standard torque loads listed in table 8 unless special torque loads are listed elsewhere.

    B. Self-locking nuts and inserts have a limited life which depends, mainly, on their ability to retain their in-built (self-locking) torque. For values of acceptable range of in-built torque, refer to table 7.

    C. In-built torque of self-locking nut or insert

Torque tightening technique (cont.)

(1) In-built torque is the torque required to start the nut or setscrew turning when:

(a) The nut is engaged on the stud or bolt (or the setscrew is engaged in the insert or captive nut) with the full chamfer of the stud or bolt (or setscrew) extending beyond the locking device of the nut, insert or captive nut.

(b) There is no axial load on the nut or bolt.

(2) Do not alter the in-built torque of a nut or insert by 'crimping' the locking device or by 'easing' it by use of a thread tap.

11. Pipe connections (union nuts, tube and hose connections)

A. Apply the torque load values listed in tables 9,10 and 11 to all standard pipe connections unless otherwise instructed.

CAUTION: PREVENT DAMAGE TO PIPES AND UNIONS BY USING A SUITABLE SPANNER TO PREVENT ROTATION OF THE UNION WHEN ASSEMBLING OR DISASSEMBLING A PIPE CONNECTION.

B. Bed-in nut and nipple connections as follows:

(1) Assemble nut and nipple to the union and tighten to the recommended torque load value.

(2) Loosen the connection by slackening the nut by half a turn.

(3) Tighten and loosen twice more.

(4) Finally tighten to recommended torque load value.

C. Rectify a leaking connection by disassembling the nut and nipple connection, examining parts for cause of failure to seal, and, if necessary, fitting new parts. Reassemble as detailed in 11.B.(1) to (4).

CAUTION: DO NOT EXCEED THE SPECIFIED TORQUE LOAD VALUE WHEN TRYING TO ACHIEVE A SATISFACTORY SEAL.

Paragraph 12 reserved

12. Torque load tables

Table 4

STANDARD TORQUE LOADS FOR DRIVING STUDS						
Nominal thread size (small end if stepped)	Minimum			Maximum		
	lb.in.	kg.cm.	N.m.	lb.in.	kg.cm.	N.m.
2 BA	21.0	24.2	2.37	42.0	48.4	4.74
10 UN	23.0	26.5	2.60	46.0	53.0	5.20
0.250 in.	45.0	51.9	5.08	90.0	104.0	10.2
0.3125 in.	104.0	120.0	11.7	207.0	238.0	23.4
0.375 in.	178.0	205.0	20.1	356.0	410.0	40.2
0.4375 in.	285.0	328.0	32.2	569.0	655.0	64.3

Table 5

STANDARD TORQUE LOADS FOR FITTING SERRATED HEAD SEALING PLUGS (UNIFIED OR WHITWORTH THREADS)			
Nominal diameter	Torque load		
	lb.in.	kg.cm.	N.m.
0.250 in.	20.0	23.04	2.26
0.3125 in.	30.0	34.56	3.39
0.375 in.	45.0	51.85	5.08
0.4375 in.	65.0	74.88	7.34
0.500 in.	90.0	103.69	10.2
0.5625 in.	90.0	103.69	10.2
0.625 in.	140.0	161.30	15.8
0.6875 in.	180.0	207.38	20.3
0.750 in.	180.0	207.38	20.3

Torque tightening technique (cont.)

Table 6

STANDARD TORQUE LOADS
FOR NON SELF-LOCKING NUTS AND FOR SETSCREWS IN NON SELF-LOCKING THREAD HOLES

Thread Size	Column A (See NOTE: 1 below)			Column B (See NOTE: 2 below)		
	lb.in.	kg.cm.	N.m.	lb.in.	kg.cm.	N.m.
6 UN	8.0	9.22	0.90	10.0	11.52	1.13
8 UN	10.0	11.52	1.13	15.0	17.28	1.69
10 UN	25.0	28.80	2.82	35.0	40.32	3.95
2 BA	25.0	28.80	2.82	35.0	40.32	3.95
1 BA	35.0	40.32	3.95	50.0	57.61	5.65
0.250 in.	75.0	86.41	8.47	100.0	115.21	11.3
0.3125 in.	135.0	155.53	15.25	170.0	195.86	19.2
0.375 in.	235.0	270.75	26.55	300.0	345.64	33.9
0.4375 in.	360.0	414.76	40.68	450.0	518.46	50.8
0.500 in.	575.0	662.47	64.97			
	lb.ft.	kg.m.	N.m.	lb.ft.	kg.m.	N.m.
0.500 in.				63.0	8.71	85.4
0.5625 in.	62.0	8.57	84.1	79.0	10.92	107.0
0.625 in.	90.0	12.44	122.0	113.0	15.62	153.0

NOTE: 1. For combinations of cadmium plated nuts with cadmium plated bolts, cadmium plated nuts with unplated bolts and unplated nuts with cadmium plated bolts, use column A of the above table.

2. For combinations of silver plated nuts with unplated bolts, unplated nuts with silver plated bolts and unplated nuts with unplated bolts, use column B of the above table.

Torque tightening technique (cont.)

Table 7

IN-BUILT (OR RUN-DOWN) TORQUE

RANGE OF ACCEPTABLE LIMITS FOR SELF-LOCKING NUTS, SELF-LOCKING WIRE THREAD INSERTS AND CAPTIVE NUTS

Thread size	Minimum			Maximum		
	lb.in.	kg.cm.	N.m.	lb.in.	kg.cm.	N.m.
4 UN	0.5	0.57	0.056	3.0	3.46	0.338
6 UN	1.0	1.15	0.113	6.0	6.91	0.676
8 UN	1.5	1.72	0.169	9.0	10.37	1.017
10 UN	2.0	2.30	0.225	18.0	20.74	2.03
0.250 in.	3.5	4.00	0.394	30.0	34.56	3.39
0.3125 in.	6.5	7.48	0.733	60.0	69.12	6.78
0.375 in.	9.5	10.94	1.07	80.0	92.17	9.04
0.4375 in.	14.0	16.13	1.58	100.0	115.21	11.3
0.500 in.	18.0	20.74	2.03	150.0	172.82	17.0
0.5625 in.	24.0	27.65	2.71	200.0	230.43	22.6
0.625 in.	32.0	36.86	3.62	300.0	345.64	33.9
0.750 in.	50.0	57.61	5.65	400.0	460.85	45.2
0.875 in.	70.0	80.65	7.91	600.0	691.27	67.8
				lb.ft.	kg.m.	N.m.
1.000 in.	92.0	105.99	10.4	66.6	9.20	90.3
1.125 in.	117.0	134.79	13.2	75.0	10.37	102.0
1.250 in.	143.0	164.76	16.2	83.3	11.52	113.0

Torque tightening technique (cont.)

Table 8

STANDARD TORQUE LOADS
FOR SELF-LOCKING NUTS, ALSO FOR SETSCREWS IN SELF-LOCKING WIRE THREAD INSERTS AND CAPTIVE NUTS

Thread size	Column A (see NOTE: 1. below)			Column B (see NOTE: 2. below)		
	lb.in.	kg.cm.	N.m.	lb.in.	kg.cm.	N.m.
6 UN	10.0	11.52	1.13	12.0	13.82	1.36
8 UN	15.0	17.28	1.69	20.0	23.04	2.26
10 UN	30.0	34.56	3.39	40.0	46.09	4.52
0.250 in.	90.0	103.69	10.17	100.0	115.21	11.3
0.3125 in.	170.0	195.86	19.2	210.0	241.95	23.7
0.375 in.	310.0	357.16	35.0	370.0	426.27	41.8
0.4375 in.	410.0	472.37	46.3	490.0	564.54	55.4
	lb.ft.	kg.m.	N.m.	lb.ft.	kg.m.	N.m.
0.500 in.	53.33	7.373	72.3	65.83	9.100	89.3
0.5625 in.	69.16	9.560	93.8	84.16	11.628	114.0
0.625 in.	100.00	13.826	136.0	120.83	16.705	164.0

NOTE: 1. For combinations of cadmium plated nuts or inserts with cadmium plated bolts, cadmium plated nuts or inserts with unplated bolts, and unplated nuts or inserts with cadmium plated bolts, use column A of the above table.

2. For combinations of silver plated nuts or inserts with unplated bolts, unplated nuts or inserts with unplated bolts and unplated nuts or inserts with silver plated bolts, use column B of the above table.

Torque tightening technique (cont.)

Table 9

STANDARD TORQUE LOADS
FOR DOUBLE-ENDED UNIONS (PARALLEL TYPE)
WHITWORTH (B.S.P.) THREAD

Outside diameter of pipe (inches)	Nominal thread diameter (inches)	Torque load		
		lb.in.	kg.cm.	N.m.
1/8	0.383	150.0	172.82	17.0
3/16	0.4375	175.0	201.63	19.8
1/4	0.518	205.0	236.19	23.2
5/16	0.600	260.0	299.55	29.4
3/8	0.656	290.0	334.12	32.8
7/16	0.750	320.0	368.68	36.2
1/2	0.825	355.0	409.01	40.1
5/8	0.902	390.0	449.33	44.1
3/4	1.041	505.0	581.82	57.1
7/8	1.189	600.0	691.27	67.8
		lb.ft.	kg.m.	N.m.
1.00	1.309	59.0	8.157	80.0
1 1/4	1.650	87.5	12.097	119.0
1 1/2	1.882	119.0	16.453	161.0
1 3/4	2.116	160.0	22.121	217.0
2.00	2.347	208.0	28.757	282.0

NOTE: When fitted into a casing or casting, the 'fast' (or casing) ends of parallel unions are subject to a torque load which, to aid security of location, is of a higher value than the torque load specified for the union nuts.

Torque tightening technique (cont.)

Table 10

STANDARD TORQUE LOADS
FOR DOUBLE-ENDED UNIONS (STEPPED TYPE)
WHITWORTH (B.S.P.) THREAD

Outside diameter of pipe (inches)	Nominal thread diameter (inches)		Torque load		
	large end	small end	lb.in.	kg.cm.	N.m.
1/8	0.518	0.383	170.0	195.86	19.2
3/16	0.518	0.4375	170.0	195.86	19.2
1/4	0.600	0.518	215.0	247.71	24.3
1/4	0.656	0.518	240.0	276.52	27.1
5/16	0.750	0.600	265.0	305.31	29.9
3/8	0.750	0.656	265.0	305.31	29.9
3/8	0.825	0.656	295.0	339.88	33.3
7/16	0.825	0.750	295.0	339.88	33.3
1/2	0.902	0.825	325.0	374.44	36.7

NOTE: When fitted into a casing or casting, the 'fast' (or casing) ends of stepped unions are subject to a torque load which, to aid security of location, is of a higher value than the torque load specified for the union nuts.

Torque tightening technique (cont.)

Table 11

STANDARD TORQUE LOADS
FOR UNION NUTS (THRUST WIRE TYPE)
WHITWORTH (B.S.P.) THREAD

Outside diameter of pipe (inches)	Nominal thread diameter (inches)	Torque load		
		lb.in.	kg.cm.	N.m.
1/8	0.383	125.0	144.01	14.1
3/16	0.4375	145.0	167.06	16.4
1/4	0.518	170.0	195.86	19.2
5/16	0.600	215.0	257.71	24.3
3/8	0.656	240.0	276.52	27.1
7/16	0.750	265.0	305.31	29.9
1/2	0.825	295.0	339.88	33.3
5/8	0.902	325.0	374.44	36.7
3/4	1.041	420.0	483.89	47.5
7/8	1.189	500.0	576.06	56.5
1.00	1.309	590.0	679.75	66.7
		lb.ft.	kg.m.	N.m.
1 1/4	1.650	73.0	10.093	99.0
1 1/2	1.882	99.0	13.687	134.0
1 3/4	2.116	133.0	18.389	180.0
2.00	2.347	173.0	23.919	235.0

APPENDIX

SPECIAL LOADINGS

1. Torque tightening procedure for specific items

A. Using engine oil as lubricant

Trimmer lever cotter pin - nut	Tighten till nipped after tapping pin home
Fuel pump governor adjusting screw - capnut	40 to 50 lb.in.
Fuel pump - drain banjo pillar - capnut	100 lb.in.
Fuel control unit - drain banjo connection - bolt	175 lb.in.
Fuel control unit filter bowl cover - retaining bolt	135 lb.in.
Oil pressure transmitter - oil feed banjo connection (Mod.323, pre-Mod.1094) - capnut	170 lb.in.
Oil pressure transmitter - oil feed pipe from transfer bobbin to bulkhead - swivel nut	80 lb.in.
Combustion chamber air casing anti-tear straps (Mod.612 or Mod.1021) - securing nuts	8 to 10 lb.in.
Fuel burners to expansion chamber - securing nuts	135 lb.in.
Expansion chamber link bolts (Mod.829) - nuts	25 lb.in. then loosen to nearest split-pin position
Expansion chamber link bolts - nuts (Mod.1350)	30 lb.in. then loosen one-sixth of a turn
Propeller controller unit - securing nuts	80 lb.in.
High-energy igniter plugs - securing capnuts	75 lb.in.
Scavenge oil filter caps - retaining bolts	135 lb.in.
Pressure oil filter cap - retaining bolt	135 lb.in.
Fuel pipe union nuts: ⅛in. B.S.P.	80 lb.in. (up to 120 lb.in. is permitted to cure a leak)
¼in. B.S.P.	120 lb.in.
⅜in. B.S.P.	150 lb.in.

Torque tightening technique (cont.)

Propeller shaft transportation cover and cap nut - torque tightening procedure:

CAUTION: ENSURE THAT A SPLIT COLLET IS FITTED TO THE PROPELLER SHAFT.

(1) Dog the engine by fitting the engine turning tool GU.15710 to the accessory drive.

(2) Tighten the end cap to the appropriate torque load using a single hexagon socket and a suitable torque spanner, as follows:

(a) Pre-Mod.443 transportation cover - end cap nut .. 30 to 50 lb.ft.

(b) Mod.443 transportation cover - end cap nut .. .. 190 to 200 lb.ft.

then:

remove the dogging tool and turn the propeller shaft to check for freedom of rotation. Refit the dogging tool and slacken the end cap fully, then torque tighten it to .. .. .. 30 to 50 lb.ft.

NOTE: The torque tightening procedure in para. (b) can be used to return the propeller shaft to its correct position if it has been displaced rearwards, using the Mod.443 transportation cover (identified by a clearance around the propeller shaft collet conical face). Pre-Mod.443 transportation covers must not be used for this procedure.

B. Using graphited grease (D.T.D.392A) as lubricant

Thermocouple - retaining setscrews	75 lb.in.
Exhaust unit - inner cone to outer cone - securing setscrews ..	120 lb.in.
Exhaust unit to nozzle box heat shield - securing nuts	170 lb.in.
Heat shield - securing nuts	75 lb.in.
Flame tube - locating pins	135 lb.in.
Combustion chamber air casing - burner cleaning access - blanking plug	135 lb.in.

C. The following items should be torque tightened without lubricant

Starter motor lead lugs - retaining nuts	110 lb.in.
Igniter lead elbow/igniter plug - securing nut	216-240 lb.in.

2. Specific items not torque tightened

Before tightening nuts by the following procedures, check that they run smoothly over the full thread range. These items should be lubricated with engine oil.

Fireproof bulkhead to compressor casing securing nuts	-	Tighten nuts until nipped then loosen by three castellations.
Hot air valve outlet to bulkhead securing nuts	-	Tighten nuts until nipped then loosen by three castellations.
Expansion chamber link bolt nuts (pre-Mod.829)	-	Tighten nuts until nipped and continue tightening by two castellations.

ENGINE INSPECTION PERIODS

The operations recommended in this section are the minimum required to ensure that the engine is in a serviceable condition. Whilst defects are not anticipated, regular inspection will facilitate detection of any fault at an early stage of its development. The recommendations in this chapter should be used as the basis for compiling the engine section of the aircraft maintenance schedule.

The stipulated time intervals between inspections are the maximum permitted and must not be extended without prior written consent; the time intervals may, however, be shortened to suit operational requirements. Extensions and/or addition to the schedule must be agreed among the Operator, Rolls-Royce and the appropriate Airworthiness Licencing Authority.

1. Recommended inspection periods

Daily check	i.e., prior to first flight and/or between flights, where stated.
50 hours	i.e., at periods not exceeding 50 accumulated hours of engine operation.
100 hours	i.e., at periods not exceeding 100 accumulated hours of engine operation.
150 hours	i.e., at periods not exceeding 150 accumulated hours of engine operation.
250 hours	i.e., at periods not exceeding 250 accumulated hours of engine operation.
300 hours	i.e., at periods not exceeding 300 accumulated hours of engine operation.
500 hours	i.e., at periods not exceeding 500 accumulated hours of engine operation.
1000 hours	i.e., at periods not exceeding 1000 accumulated hours of engine operation.

2. Definitions

For the purpose of this section the following definition of terms will apply:

Inspection	Establish the condition of a component or system, using visual aids and/or measuring equipment and all processes detailed in the relevant inspection check. Where applicable, apply the approved acceptance standards.
Examine	Establish the condition of a component or system using visual aids only.

3. Recommended routine inspections (cont.)

	Daily check	50 hrs.	150 hrs.	250 hrs.	500 hrs.	1000 hrs.	NATURE OF INSPECTION	Chapter reference
1	*						Check oil level(or at intervals not exceeding 8 hours) and replenish if necessary	72-8
2	*						Spin propeller by hand to check for resistance to turning (also between flights)	72-0
3	*						Examine air intake and de-icer pads, oil cooler and duct (also between flights); if signs of ingestion of debris is evident, also examine the compressor first-stage rotating guide vanes with a strong spotlight	72-1 72-3 72-8
4	*						Examine the turbine and exhaust unit using a strong spotlight	72-6 72-7
5	*						Function check the engine controls and feathering pump	76-0
6							* Remove and examine magnetic chip detector plug	72-8
7				*			Remove and examine the pressure and scavenge oil filters (engines not incorporating Mod.529, Part 2)	72-8
7A		*					Remove and examine the pressure and scavenge oil filters (engines incorporating Mod.529, Part 2)	72-8

* On Mod.1316 engines the magnetic chip detector should be removed at convenient periods (e.g.20 to 30 hours) between filter inspection periods and examined for metal particles to supplement filter inspections.

3. Recommended routine inspections (cont.)

	Daily check	50 hrs.	150 hrs.	250 hrs.	500 hrs	1000 hrs.	NATURE OF INSPECTION	Chapter reference
8					*		Examine Mk.529-7H and 532-7 engines and Mk.528 series engines with Mod.1138 embodied, for evidence of localized overheating of the flame tube air casings	72-5
9					*		+ Examine the igniter plug leads and aurally check the igniter system for correct functioning	80-2
9A	At half approved engine overhaul life						Remove and clean combined drain valve and return spring	71-1
10					*		Remove cowlings and examine the engine for fuel, oil and gas leaks. Examine each fuel burner feed pipe for indications of deterioration. Examine the engine generally for condition and security of components.	72-0 72-5 72-8 73-0
11					*		Inspect the compressor first-stage rotating guide vanes using an internal viewing instrument, and examine the compressor casings for cracks.	72-3

+ Although a physical and aural check is specified at 500 hour intervals, it is recommended that an aural check be made as often as possible.

3. Recommended routine inspections(cont.)

	Daily Check	100 hrs	150 hrs	300 hrs	500 hrs	1000 hrs	NATURE OF INSPECTION	Chapter reference
12					*		Functionally check the power plant ice protection system.	30 71-0
13					*		Examine the hot air valve and check the operation of the solenoids aurally; functionally check the fuel de-icing system.	71-0 75-1
14				*			Examine the control rods for possible distortion and check rod-ends for safety, security and correct locking; lubricate the control box, cross-shafts and ball joints.	76-0
15					*		Examine a fuel sample drained from the L.P. fuel filter.	73-4
16					*		† Check fire extinguisher spray pipes.	26 or 71-2
17						*	Test thermocouples and harness circuit resistance, continuity and insulation resistance in conjunction with item 25.	77-2-1
18					*		Check torque loading of the propeller controller unit retaining nuts.	89-3

† If fire extinguisher spray pipes are coated with grease, dirt or oil, they must be cleaned and the discharge holes checked for obstruction. Chafed pipes must be renewed and checked for obstruction after installation.

3. Recommended routine inspections (cont.)

	Daily Check	100 hrs.	150 hrs.	250 hrs.	500 hrs.	1000 hrs.	NATURE OF INSPECTION	Chapter reference
19					*		Examine the combustion chambers and interconnectors for gas leaks, cracks and damage. Check flame tube suspension pins for security. On Mod.612, 1021 and Mod.1442 engines check the anti-tear straps for security cracks and damage	72-5
20					*		Examine air casings for corrosion (Operators with under 1,000 hrs. utilization per annum).	72-5
21					*		Check fuel control unit ram air pipe (pre-Mod.906 and 1188 engines only).	72-0
22					*		Examine air casings for corrosion (Operators with over 1,000 hrs. utilization per annum).	72-5
23						*	Check fuel pump governor setting.	73-2
24						*	Inspect igniter H.T. leads.	80-2
25						*	Carry out serviceability ground run and engine power check at 50, 500 and 1,500 flying hours from installation; thereafter at 1,000 hour intervals	71-0 71-0 Page 102 para.B.
26	Refer to Chap.73-1						+ Clean the fuel burners.	-
27	Refer to Chap.72-3 and 72-5						Soft blast the compressor and check the inter-connector sealing rings for evidence of gas leakage.	-

+ This applies only where air washed burners are fitted; fuel washed burners (Mod.1536,S.B.No.Da 73-56) must not be cleaned.

3. Recommended routine inspection (cont.)

	FLAME TUBES	NATURE OF INSPECTION	Chapter reference
28	Refer to Alert Service Bulletin Da72-A413 or Service Bulletin Da72-420 as appropriate to the modification standard of the engine	In-service inspection of flame tube suspension for integrity	72-5, 5. Inspection check.

LIST OF ASSOCIATED PUBLICATIONS

	Publication No.
Starting and operating instructions — Fokker Friendship	F-Da7-FoF
Starting and operating instructions — Fairchild Friendship	F-Da7-FaF
Modifications Manual	T.S.D. 266
Schedule of spare parts, Dart 528	S-Da528
Overhaul Manual	O-Da7-AC
Overhaul process equipment for Operator's workshops	T.S.D. 452
Engine overhaul processes	T.S.D. 594
Overhaul planning — Dart engines	OP-Da

RUBBER AND SYNTHETIC RUBBER PARTS - SHELF LIFE, STORAGE AND INSPECTION

1. Shelf life

A. The cure date is the reference point from which the shelf life of rubber and synthetic rubber parts is calculated. It is marked on the parts and/or on their associated packaging and applies to all 'uninstalled' rubber or synthetic rubber parts, bonded rubber to metal parts, cables, harness, hoses and hose assemblies but not to assembled units and accessories, (such as fuel units).

B. The cure date is shown as the quarter of the year (expressed as a single figure) and the year (expressed as a double figure) of manufacture separated by the letter Q: e.g. 2Q68 is the cure date for a part manufactured in the second quarter of 1968. The year is divided into quarters as follows:

(1) January, February, March.
(2) April, May, June.
(3) July, August, September.
(4) October, November, December.

NOTE: On some parts, the month of manufacture may be shown in brackets after the cure date, e.g. 2Q68(May).

C. The age of any part is calculated from the end of the quarter in which the part was manufactured. Thus a part with the cure date 2Q68 would be one year old at the end of the second quarter of 1969, i.e. 30th June, 1969.

2. Cure date marking

A. The method of showing the cure date of 'uninstalled' or 'separate' rubber or synthetic rubber parts is as follows:

(1) Individual parts (except sealing rings) large enough to be marked, e.g. diaphragms and bulkhead seals, are stamped or stencilled with a permanent marking fluid of a contrasting colour.

(2) Individual parts which cannot be marked owing to size, and sealing rings, are packed in marked envelopes supplemented by labels attached to the part or batch.

(3) All basic envelopes, bags or packages and all intermediate and/or exterior containers in which the items are packaged are marked with the cure date. In addition each envelope, bag or package shows the manufacturer's name or reference, Rolls-Royce part number and batch number.

Rubber and synthetic rubber parts - Shelf life, storage and inspection (cont.)

(4) Hoses are marked with 2 separate groups of figures and letters which are repeated along the full length of hose. The first group gives manufacturing data such as 'mix' information, whilst the second group gives length or batch number and cure date as follows:

First 4 figures - length of batch number

Next or middle figure and letter - quarter symbol and 'Q') cure date
Final 2 figures - year symbol)

Example: 01012Q68 - 101st length or batch produced in the second quarter of 1968

(5) Hose assemblies are, in addition to the coding on the hose element, marked by the following identification tabs:

(a) Coding tab (repeat of hose coding).

(b) Identification tab (showing hose piece number, test date, inspector's stamp and maker's identification).

(c) Cure date tab (showing cure date of hose).

(6) All basic packaging and all intermediate and/or external containers for hoses and hose assemblies are marked with the cure date.

3. Storage of parts

A. Maintain rubber and synthetic rubber parts in good condition and ensure maximum shelf life by careful attention to storage conditions. Store parts under conditions which provide the maximum possible protection against the effects of strain, direct sunlight, ozone, moisture, excessive circulation of air, extremes of temperature, physical damage and contamination by fuels, oils, greases, or solvents. If the parts are supplied packed in envelopes, plastic bags or cartons, they should be kept in this condition until required for service. Avoid excessive shelf storage time by relating level of stocks to rate of use and by issuing parts on an 'age' basis, that is, oldest items, as shown by cure date, first. Do not allow direct contact between rubber parts and metals (especially containers made from copper).

B. Store parts in a relaxed position free from tension and, wherever possible, in their normal shape. Avoid excessive vertical stacking of parts as this can cause permanent distortion of the lower layers. Store flexible hoses in straight lengths, wherever possible, as 'coiling' produces tension in the outside of each coil and increases the risk of ozone cracking.

C. Provide sufficient ventilation to prevent condensation but prevent currents of air from coming into contact with the stored parts. Avoid, as much as possible, sources of ozone such as mercury vapour lamps, electrical machinery and an excess of outdoor air which, in temperate climates, always contains ozone. Ensure that parts are shielded from direct sunlight.

D. Store lip type seals in such a manner that damage and distortion to the sealing edge is avoided, and do not tie labels directly to the seals. Do not fit sealing rings to ferrules or bobbins until immediately before installation into an engine or unit as stretching and exposure to light can cause deterioration.

E. Maintain storage temperature within the preferred range of 15 to 21 degrees C. (59 to 70 degrees F.) with a minimum of 5 degrees C. (41 degrees F.) and a maximum of 38 degrees C. (100 degrees F.), and an air relative humidity of 65 per cent. Store parts at least 3 feet from any unscreened source of heat.

F. If stored under the preceding recommended conditions the shelf life of rubber parts is virtually unlimited, subject at specified intervals in certain cases to a monitoring inspection. For this purpose, rubber types have been divided into 3 groups.

Group A

	Material specification
Natural rubber	MS717

These can be supplied to a customer up to 5 years from cure date. The subsequent shelf life is unlimited, subject to satisfactory inspection (see para.4) of a sample of the oldest stock at least every 2 years.

Group B

	Material specification
Butyl	MS 754, 757
Neoprene (Chloroprene)	MS 710, 716 (BS 2752 grade C3 or C4)

These can be supplied to a customer up to 7 years from cure date. The subsequent shelf life is unlimited, subject to satisfactory inspection (see para.4) of a sample of the oldest stock at least every 3 years.

Nitrile	MS 727, 735, 743, 744, 747, 765 MSRR 9454, 9455 BSEM 602 DTD 5509, 5595, 5607

These can be supplied to a customer up to 10 years from cure date. The ultimate life is 15 years.

Group X.

	Material specification
Silicone Fluorosilicone Fluorocarbon (Viton)	MS 732, 741, 751, 756, 761, 771 MSRR 9450 (MS 762), 9451 (MS 782), 9452 (MS 766), 9453, 9490 BSEM 608, 534 DTD 900/4822A, 5543, 5603, 5612, 5613

There is no life limit for supply to a customer or for storage. Cure date marking has been retained only to assist stock monitoring.

NOTE: 1. Rubber parts in Groups A and B (except Nitrile) supplied to a customer for immediate use on engines and therefore not intended to be stored, may have exceeded the cure date limit. This is acceptable since the vendors storage conditions are close to ideal.

2. Material spec. numbers are marked on packaged components only.

4. Inspection of parts

A. Examine parts for signs of 'ageing' or degradation due to oxidation. This is shown by surface cracks and deterioration. To check, flex the part gently and discard if cracks are present before or after flexing.

Rubber and synthetic rubber parts - Shelf life, storage and inspection (cont.)

B. Do not automatically discard parts due to the presence of a white or coloured 'bloom' on their surface. Such blooms are often desirable anti-ageing layers and originate from the anti-oxidants used in high grade rubber.

C. Examine, and discard if faulty, all parts for:

(1) Permanent distortion, flats and other obvious defects.

(2) Tackiness or surface hardening or softening.

(3) Blistering, peeling or cracks when rubber is extended or flexed.

(4) Chafing of outer covering and corrosion of, or damage to, end fittings of hose assemblies and cable harnesses.

(5) Corrosion of metal elements in bonded rubber to metal assemblies.

(6) Obstruction of the bore (flexible hoses).

D. Pressure test flexible hoses as instructed in the relevant sections of this manual. If it is essential to fit a flexible hose when no facilities for pressure testing exist, then the hose must be removed for testing at the first available opportunity. On completion of pressure testing, drain the hose, blow through with clean air and seal the ends with blanks.

E. Test electrical cables and harnesses for resistance, leakage and conductivity, as well as for chafing of the loom and satisfactory condition of the end fittings, as instructed in the relevant sections of this manual.

SEALING RINGS

1. Identification

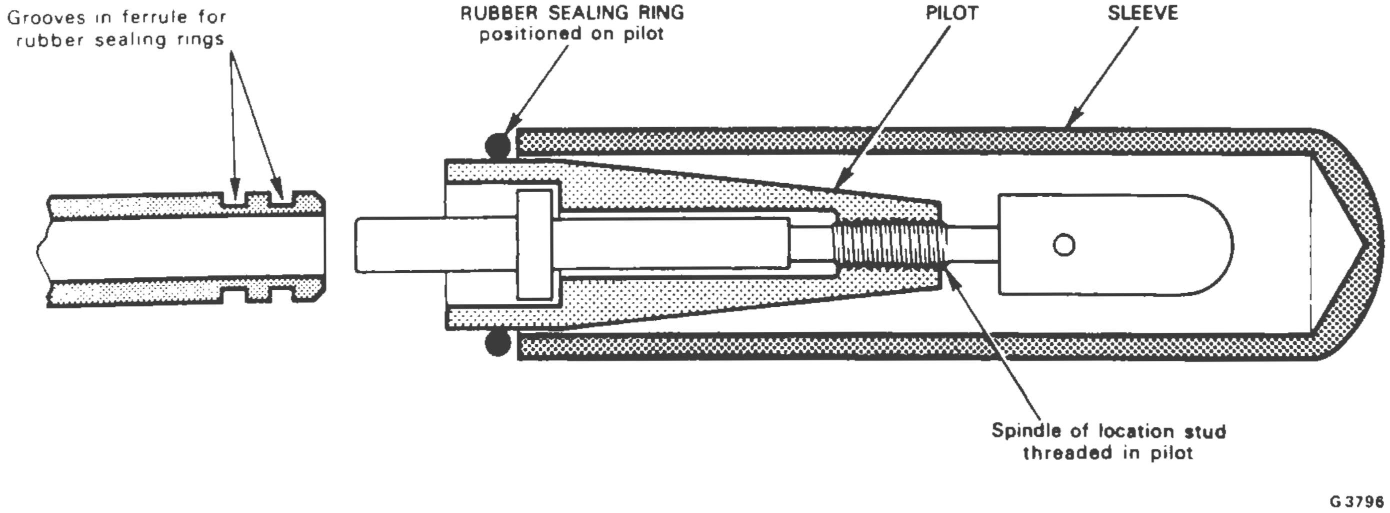
A. Rubber sealing ring identification is by the part number which is shown on the envelope in which sealing rings are individually packed. On the envelope (and on all associated packaging) is marked, as a minimum, the following information (examples given in brackets):

Description of part	(ring, sealing)
Quantity	(one, 1)
Rolls-Royce part number	(000,000)
Cure date	(2Q68)

B. The sealing ring material is identified by self-colouring of the ring or by colour coding markings on the ring. A sealing ring which has become separated from its envelope can be identified as follows:

(1) Match the colour code marking on the sealing ring with the same marking in the identification of rubber sealing rings shown in Table 1. Record the material code shown.

(2) Refer to the appropriate Illustrated Parts Catalogue which relates the material code to the sealing ring part number, material description, dimensions and location.


Grooves in ferrule for rubber sealing rings
RUBBER SEALING RING positioned on pilot
PILOT
SLEEVE
Spindle of location stud threaded in pilot
G3796

Typical pilot and sleeve assembling tool
Fig.1

Sealing rings (cont.)

IDENTIFICATION OF RUBBER SEALING RINGS

Identification colour code		Material code
Base colour	Number and colour of spots or lines	
black	1 yellow	F/E or WAD
black	1 yellow, 1 white	PE/FK or WAJ
black	1 yellow, 1 blue, 1 green	R/G or WAG
black	2 yellow	E/ORK
black	2 yellow, 1 blue	PE/EK or WAM
black	2 yellow, 2 green	VE/S or WAT
black	3 yellow	PE/OZR or WAK
black	4 yellow	VE/KR or WAS
black	part number in white ink	PE/DCR or WAL
black	1 white, 1 blue	PE/ELR
black	1 white, 2 blue	B/SK or WAB
black	1 white, 2 green	E/PVC or WAQ
black	1 white, 1 blue, 1 yellow	E/XCF or WAP
black	1 blue, 1 green	E/ORP
black	1 blue, 1 white, 1 green	PE/ERS
black	1 blue, 1 green, 1 yellow	N/GP or WAC
black	2 blue	E/ORS
black	3 blue	N/Q
black	1 green, 1 white	PE/FR
black	1 green, 1 yellow	E/OR
black	1 green, 2 yellow	E/ORK or WAN
black	3 green	PE/RN
black	4 green	VE/HT or WAR
brick red	2 black graphite	SE/DT
red	1 green	GF/ST
red	None, self-coloured	E/ET
orange	None, self-coloured	SE/MP or WAH
green	None, self-coloured	SE/F
blue	None, self-coloured	SE/G
pale blue	None, self-coloured	SE/CH or WAU
grey	None, self-coloured	SE/FM
brown	None, self-coloured	SE/MH
brownish red	None, self-coloured	SE/DTA
light brown	None, self-coloured	WAF
brown	None, packaged	WAY
brown	None, packaged	WAZ

Table 1

Sealing rings (cont.)

2. Lubrication

A. Avoid indiscriminate use of lubricants when fitting rubber sealing rings: use only the recommended lubricant and apply sparingly immediately before fitting the rings to a unit or engine. Failure to observe the foregoing instructions can result in premature swelling of the rubber sealing rings during assembling.

CAUTION: DO NOT USE A LUBRICANT ON RUBBER SEALING RINGS OTHER THAN THAT RECOMMENDED FOR THE PARTICULAR APPLICATION.

B. The choice of lubricant is controlled by the environment of the rubber sealing rings, i.e. air, fuel or oil system, rather than by the type of material from which they are manufactured. Unless otherwise instructed, the lubricants to be used during the fitting of rubber sealing rings are as follows:

(1) Air system - silicone rubber lubricant, OMat 418.

(2) Fuel system - liquid paraffin, OMat 1020.

(3) Oil system - clean engine oil, OMat 1011.

3. Fitting

A. Use new rubber sealing rings when assembling units or engines.

B. Ensure that the life and condition are as detailed in 'Rubber and synthetic rubber parts - shelf life, storage and inspection' for sealing rings before fitting them in a unit or engine.

C. Ensure that grooves and mating faces, to which the rubber sealing rings are to be fitted, are clean and smooth then lightly smear the grooves and mating faces with the recommended lubricant. Apply the lubricant, sparingly, to the total surface area of the rubber sealing rings before fitting.

D. Take care to avoid stretching or twisting the rubber sealing rings whilst fitting: ensure that when fitted the rings are not twisted and that they are correctly seated in their grooves.

Sealing rings (cont.)

E. Do not fit rubber sealing rings to any section of the engine whilst it is still hot, otherwise the sealing rings may stretch and be more liable to damage.

F. Prevent rubber sealing ring breakages when fitting these items in such locations as fuel pipe double grooved ferrules by using a suitable pilot and sleeve assembling tool (Fig.1).

G. Before fitting ferrules and tubes into their mating sockets check that the exposed surfaces of the rubber sealing rings are thinly coated with the recommended lubricant. Use a straight pushing movement to fit the ferrules and tubes into their sockets; this action will prevent twisting of the rubber sealing rings.

TURBINE FUEL HANDLING AND QUALITY CONTROL

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The following fuel handling and quality control procedure has been compiled by Rolls-Royce in conjunction with certain major Fuel Suppliers for the guidance of Operators.

INTRODUCTION

Fuel contamination can broadly be separated into two categories, water and solids, either organic or inorganic.

Water

A maximum free and suspended water content of 30 p.p.m. (excess over saturation) can be tolerated in the uplift of turbine fuels as a realistic figure recognisable by the available fuel test equipment.

Aircraft and engine fuel systems are designed to cater for limited quantities of water in the fuel supply. With fuel heating fitted, the engine will function satisfactorily with a total maximum water content of 0.025% by volume, including the normal amounts of dissolved water (up to 0.02% depending on the temperature of the fuel and the atmospheric conditions).

The engine may not function if slugs of water pass into it, and it is obviously not practical to cater for unlimited quantities of free or suspended water in the fuel. It is therefore necessary to take stringent precautions to ensure that fuel is delivered to the aircraft free from suspended or free water above a concentration of 30 p.p.m.

Solids

It is considered that at present 1 mg/litre dirt content is a workable maximum for fuel as delivered to the aircraft. This is quoted as an absolute maximum on a worldwide basis assuming that on most occasions fuel will be delivered to a much lower dirt content. This maximum limit should include both organic and inorganic matter since both affect the engine fuel system.

A. MOBILE REFUELLING

1. Airfield storage tanks

(a) Storage tanks should be inspected at intervals of not more than 18 months and upon any indications of rust contamination (e.g. by clogging of bulk filters at more frequent intervals than considered normal) the tanks should be drained and scoured in accordance with local practice. Change the filter element as necessary.

(b) It is desirable that airfield storage tanks should be filled through an adequate filter.

(c) After refilling, the fuel should be allowed to settle for as long a period as possible. For tanks without floating suction, after the discharge of fuel into the storage tank, it should be allowed to settle for at least 1 hour per foot of depth of the product in the tank before any withdrawals are made. Where floating suctions are employed, a five-hour minimum settling time should be allowed. After this fuel may be drawn off to a depth of four feet below the initial level of the fuel. The rate of withdrawal of fuel thereafter is controlled by the need to permit the fuel to be settled at a rate of one foot per hour.

(d) Checks for free water must be carried out after the settling period, daily, and after heavy rain. Water detecting paper or paste should be used for these checks. Since these reagents are effective only when brought directly into contact with bulk free water, they should be applied to the end of a rod or dipstick so that sampling is

Turbine fuel handling and quality control (cont.)

carried out at the bottom of the tank.

Two typical examples of water detecting reagents are:

(i) A water detecting paper which is normally brown, the presence of water being shown by the removal of the colouring, leaving a white surface. Reaction time is about 10 seconds.

(ii) A paste which is normally green and which in the presence of water changes to lavender. Reaction time should not exceed 10 seconds.

If water is found it must be drawn off completely from the tank.

2. Transfer of fuel from airfield storage tank to refueller

(a) Floating suction is generally employed for the off-take of fuel from storage, although in isolated cases bottom suction may still be encountered. In either case an efficient water separator/filter is strongly recommended between the storage and the refueller. If this is not possible at this point nominal 5 micron filtration must be provided. Differential pressure gauges must be fitted on water separators and/or micro filters and frequent records taken. Drain the water separator sumps daily. regular checks should also be made to ensure floating suction is operating correctly.

(b) With either method of offtake fuel should not be taken at less than nine inches from the bottom of the tank to ensure that any water or solid contaminant which has settled out will not be transferred to the refueller.

Turbine fuel handling and quality control (cont.)

(c) Closed circuit filling should be used, wherever possible, but where this is not provided the filler orifice on the refueller should be shrouded to prevent ingress of water and foreign matter.

(d) Bottom loading should be employed wherever possible alternatively the filler pipe from the storage should discharge at the bottom of the refueller tank.

3. Aircraft refueller.

(a) The refueller should be allowed, where practicable, to stand for at least 10 minutes after being refuelled to allow contaminants to settle out.

(b) A sample of at least one gallon of fuel should be drained from the refueller at full flush into a clean and dry clear glass container and then a contamination check carried out. The sample should be taken from the sump of the refueller, where fitted. In the case of compartmented refuellers, the sample should be taken from the drain point in each compartment.

Solids - If contamination is visible in the glass container sampling must be repeated until the acceptable standard is achieved.

Free water - Should be detected by the use of water detecting media, such as paste, paper or suitable types of chemical detector.

Suspended water may be indicated by a cloudy appearance of the sample. It is of assistance to have available a sealed vessel of the same type as is being used for the sampling, and containing clean, bright, fuel, for purposes of comparison. The sample should always be viewed under standard conditions, preferably against a black background, and at night, with a torch held so as to shine through the sample at right angles to the line of sight. Chemical detectors are available and will give more positive indication of suspended water. These should be used in addition to visual detection. Recommended types of chemical detector are described later in this section.

(c) In the event of free water being found, the refueller should be driven in order to agitate the fuel and then allowed to stand for a period of 10 minutes when another water check should be made, and the procedure repeated until the fuel sample is free of water.

(d) In the event of suspended water being found, the fuel load must be rejected.

(e) Following either (c) or (d) above the source of the contamination must be investigated.

4. Transfer of fuel from refueller to aircraft

(a) Should an Operator wish for an independent check for water contamination, it is recommended that this be carried out before refuelling commences. Refuelling should only commence after fuel has been shown to be free from water.

(b) A 5 micron (nominal) filter or filter/separator should be fitted to the delivery side of the refueller.

(c) Dust covers on refuelling nozzles or connections should not be removed until immediately prior to the transfer of fuel and replaced as soon as transfer is completed. Dust covers, shrouds and nozzles must not be allowed to trail on the ground.

Turbine fuel handling and quality control (cont.)

(d) When overwing refuelling is carried out the aircraft filler orifice should be shrouded to prevent ingress of water or foreign matter.

(e) The most desirable check point for dirt contamination of fuel is where the fuel is delivered to the aircraft. If an Operator wishes to make a full flush check it should be done at this location.

5. General

(a) All equipment should be kept scrupulously clean.

(b) Whenever new equipment (e.g. storage tanks or refuellers) is brought into use, major repairs carried out, or the grade of fuel in use is changed (e.g. Kerosine or wide-cut) particular care should be taken in handling the fuel and making the quality checks. Since under these conditions there is a greater tendency for any rust that is present to be dislodged, micronic filter differential pressures should be carefully watched, and the filter back flushed or the element changed, according to type, as soon as the recommended safe maximum pressure differential is reached.

(c) It is important that relaxation of precautions should not be allowed to occur at any time because, for example, over a period of several months no evidence of contamination has been found. It is equally important that there should be no seasonal changes in the procedures, as, although aircraft fuel system icing due to water contamination is more often met with in winter, contamination of any sort can be equally dangerous during the summer months, and it should be remembered that, on many aircraft, fuel cooling in flight will give fuel temperatures well below zero throughout the year.

B. HYDRANT SYSTEMS

1. Airfield Hydrant Depot

The same precautions apply here as described for airfield storage tanks under A.1. It should be noted however that hydrant systems are even more critical than other types in view of the difficulties involved in contamination removal.

2. Hydrant Pipe Line

(a) Floating suction should be used for the off-take of fuel from storage with an efficient water separator between the storage and the pipe line. Differential pressure gauges or water separator equipment should be checked frequently and water sumps drained daily. Floating suction must be checked at regular intervals.

(b) Fuel should not be taken at less than nine inches from the bottom of the tank, to ensure that any water or solid contaminant which has settled out will not be transferred to the pipe line.

(c) The pipe line should be graded down to a sump or sumps.

(d) A daily contamination check should be made from the pipe line sump or sumps. At least one gallon of fuel should be drained off at the maximum rate possible, into a clean and dry clear glass container, ensuring that this sample is representative of the contents of the sump. The sample should then be tested for water and solids as previously described.

(e) In the event of contamination being found, the source of contamination should be established and cleared before the hydrant is returned to service.

3. Dispensing Unit

(a) A daily check should be made from the draining points on the dispenser, as previously described for refuellers (A.3 (b)).

(b) If any serious contamination is found, use of the hydrant should be discontinued and the dispenser withdrawn from service until the source is discovered and eliminated.

(c) In view of the fact that there is no intermediate settling period between storage and aircraft, as in the case of mobile refuellers, particular care must be exercised in the checking of hydrant systems.

(d) It is essential to make further checks from the dispenser during or immediately after each refuelling operation.

4. Transfer of fuel from dispenser to aircraft

The same recommendations as for mobile refuellers (A.4) apply.

5. General

(a) All equipment should be kept scrupulously clean.

(b) Whenever new installations are brought into use, major repairs carried out, or the grade of fuel changed in a hydrant system, fuel should be circulated through the system, with suitable filters in circuit, to flush out and drain the system of solid contaminants or water. This re-circulating should continue until the product is clear. In addition during the early life of the system, particular attention should be paid to the behaviour of micronic filters and the filter elements should be changed as necessary.

(c) The recommendation of A.5 (c) regarding relaxation of precautions is particularly emphasized in regard to hydrant installations because of the lack of an intermediate settling period between storage and aircraft.

C. REFUELLING FROM DRUMS

1. General

(a) Refuelling aircraft from drums, barrels, cans or other containers is not a recommended procedure. At certain outlaying airfields, however, it is occasionally necessary to refuel directly from this type of container.

(b) Drum stored fuel should always be treated as suspect, hence extraordinary precautions are necessary to eliminate water and solid contamination of the fuel.

2. Drum Construction and Material

Drums used for storing aviation turbine fuel should be constructed of plain drum steel, preferably lined with an approved lacquer which is unaffected by fuel or water contamination, though when this is done care must be taken to ensure that the lacquer does not flake off if a drum should become dented. Galvanized interiors should never be used, although the exterior may be galvanized to prevent rust.

3. Storage

(a) Drums should be stored preferably under cover off the ground and on their sides with all bungs beneath the product level and in such a manner that they are visible and accessible, to prevent rain water from entering through faulty bungs.

(b) Each grade and batch of fuel should be segregated and be prominently labelled, and should be used on a "first in - first out" basis.

(b) A daily check for leaks should be carried out, and leaking drums should preferably be returned to the Fuel Supplier for passing through his quality control procedures. Where this is impossible, the checks described in para. C.4 should be carried out and the contents if satisfactory decanted into sound drums.

(d) The drum markings should be inspected frequently for legibility.

(e) Samples for laboratory analysis should be drawn not later than 12 months from the filling date and subsequently at intervals of not more than 6 months.

4. Pre-fuelling operations

(a) Prior to refuelling, all the drums required for a particular operation should be rolled out and placed in position, close to the parked aircraft or where it will be parked, bungs uppermost.

(b) Sparks may be caused when drums are moved, hence because of the possible presence of inflammable or explosive fuel vapour, unnecessary movement of drums during refuelling should not be permitted. If movement is essential this should be carried out with care.

(c) The fuel should then be allowed to settle for as long as possible, and in any case not less then 10 minutes, before checking commences.

(d) As the bung is removed from each drum a free water check should be made by means of water detecting paste or paper on the end of a rod to sample the liquid at the bottom of the barrel. (See para. A.1 (c).). If possible, a sample should be drawn off by "thief" pump or plastic tube and submitted to a visual check for colour and solid contaminants and visual and chemical check for suspended water. (see para. A.3 (b).).

(e) If free water or solid contaminant is found, it should be drawn off and the contents of the drum decanted into a clean and dry container, which should then be allowed to settle. Before use carry out check (d) again.

(f) If suspended water is found, the drum should be rejected, removed to a location where it is unlikely to be used by mistake, and the grade markings cancelled, the batch code being retained.
The source of contamination should be investigated in order to prevent possible recurrence.

(g) After the contaminant checks have been carried out, the bungs should be replaced until a drum is actually required for refuelling.

(h) Note that it is extremely important to check each individual drum, as there is no guarantee that any particular batch of drums is free from contaminants.

5. Refuelling

(a) The fuel should be withdrawn from the drums by means of a drum standpipe made of brass, or steel sheathed with copper or brass. The pipe should have the bottom end cut off at an angle such that the bottom 3 in. of the drum contents will not be withdrawn, and should fit the bunghole, or be provided with a shroud to cover the bunghole.

(b) The standpipe should be connected to a suitable hand or power-operatred pump, which should then deliver through a 5-micron (nominal) filter and thence to the delivery nozzle which should shroud the filler neck. The pump should be situated close to the drums and not on the aircraft wing.

(c) If a micronic filter is not available, some protection is afforded by delivering to the aircraft filler via a chamois leather or a nylon cloth filter, which should shroud the filler neck. This should, however, only be considered as a last resort.

6. Bonding

Before refuelling commences it is essential that electrical continuity throughout the system from drum to aircraft is ensured. This is normally obtainable as follows :

(a) Provision of a bonding clip connection between standpipe and barrel.

(b) Electrical continuity through hoses and pumping equipment.

(c) Provision of a bonding cable on the pumping equipment, the cable to be connected to the aircraft structure before taking out the delivery hose.

Turbine fuel handling and quality control (cont.)

(d) Filling nozzles and funnels, if used, to be provided with bonding clips to ensure continuity from nozzle through to aircraft structure.

7. Re-use of drums

It is strongly recommended that drums should not be re-used for aviation fuel unless re-submitted to the Fuel Suppliers' cleaning procedures. If, however, circumstances demand that they must, the following precautions should be observed.

(a) Before re-filling, the drums should be cleaned and carefully examined internally for good condition and freedom from contamination.

(b) New bung washers should be used after re-filling.

(c) Previous markings on the drum, if different from the product in hand, should be destroyed, and new markings stencilled on.

(d) Under no circumstances should a drum previously used for any other products be re-used for aviation fuel.

D. AIRCRAFT REFUELLING CHECKS

(a) Before and after refuelling has been completed it is recommended that a water drain check should be made at the aircraft, checking samples from all relevant drain points. This is particularly important where aircraft turnrounds are of short duration and settling time after refuelling may consequently be inadequate. Where possible at least 20 minutes should elapse before sampling.

(b) Free water should be detected by means of paper or paste or suitable types of chemical detector and suspended water by visual and chemical means. (See para. A.3 (b).).

(c) If free water is found, continue to draw off samples until the fuel is free from water.

(d) If suspended water is found, the cause must be established. Cloudiness of the fuel samples caused by precipitation from solution when the warm fuel meets the cold fuel may be disregarded provided that it has been established that the previous and the present uplift are free of water.

E. THE ENGINE L.P. FILTER

Because of the very high rating of the engine L.P. filter and the Rolls-Royce policy not to permit a by-pass which might allow unfiltered fuel to reach and contaminate the engine fuel system, the engine filter is not designed to hold large amounts of cumulative dirt but is only intended to cope with small amounts of dirt normally encountered in the average aircraft system or a sudden emergency of short duration. In addition it is intended to give a final polish up to already clean, dry fuel. It does, however, provide the last line of defence in combating contamination and provides a valuable guide to the Operator in the assessment of fuel quality. From the point of view of the engine it is considered that the L.P. filter is one of the best known indicators of fuel contamination or of breakdown in the airport supply system and for this reason, where contamination is thought to exist, Laboratory examination of engine filter elements will often give a useful lead to the source of breakdown. It must be accepted that the lower the fuel standard the more frequent must be the engine L.P. fuel filter changes.

F. CORROSIVE SULPHUR

It is known that corrosive sulphur in aviation fuel can cause serious damage to aircraft and turbine engine fuel system components, particularly fuel pumps. In general this formation is associated with unsatisfactory storage conditions, inadequate fuel handling and quality control and climatic environment, the danger being greatest in warmer climates. The following notes are given as a guide to identification of corrosive sulphur in fuel, the cause of formation and means of testing.

General

Corrosive sulphur can form in aviation fuel stored in contact with water in which active sulphate reducing bacteria is present. This is most likely to occur in storage tanks or bulk containers which have deteriorated due to inadequate cleaning and maintenance.

The bacteria causing the formation of corrosive sulphur in stored fuel thrive in stagnant, unaerated water, particularly if the water contains sludge and decaying organic matter. These bacteria, in their life cycle, give rise to sulphides, such as sulphuretted hydrogen, the greatest reaction being when the water temperature is higher than 25°C and in contact with iron. Activity is equally virulent in salt or fresh water and can persist in sludge.

Dangerous pollution can occur in a relatively small quantity of water or sludge the degree being directly related to the cleanliness of the storage tank. The greatest rate of fuel contamination occurs with only a small quantity of fuel in the tank and this condition should be regarded as the most dangerous.

If for any reason the presence of corrosive sulphur in fuel installations is suspect, the following tests should be applied.

1. Method of checking for sulphides

   The method of testing a tank for the presence of sulphides is to take a sample of the water and sludge from the bottom of the tank, acidify the water and check for the evolution of hydrogen sulphide by the use of a lead acetate paper.

   The sample should be taken in a clean, sterile,dark glass bottle; a metal container must not be used. In all probability the sample will consist of water and fuel, therefore, before carrying out the test for sulphides, the fuel must be removed from the sample.

   The test should be carried out with as little delay as possible after taking the sample, to the following method:

   1. Shake the sample so that any sediment will be suspended in the water. This is essential as the sediment may consist of iron sulphide produced by sulphate-reducing bacteria.
   2. Transfer 100 ml. of the water/sediment suspension to a conical flask of 200 ml. capacity.
   3. Add to the flask 20 ml. of a 10% solution of dilute sulphuric acid and immediately place in the neck of the flask a lead

acetate paper folded to the shape of a V.

4. Bring the water to the boil, and continue to boil it gently for three to four minutes.

If the lead acetate paper turns black or brown, sulphides are present in the sample.

2. Method of testing fuel in bulk storage

The fuel should be subjected to a copper strip corrosion test for 2 hours at 100°C in accordance with the latest issue of the American Society for Testing Materials (A.S.T.M.) Method D.130, Paragraph 7(b), or Institute of Petroleum (I.P.) Method 154, Procedure 'C'. The current editions of these documents are D.130-56, and 154/58 respectively.

Attention should be paid to the following points:

1. The fuel sample should be drawn from the lower half of the tank in a clean, dark, glass bottle, and every precaution taken to shield it from strong natural light. Do not use a metal container for this purpose. No undue delay should occur between taking the sample and making the test.

2. If the copper strip test result is worse than Classification No. 1 of either the A.S.T.M. Method or the I.P. Method, the fuel should be rejected as unfit for use and removed from the tank. When the fuel has been removed, the tank freed of gas, and the usual safety precautions taken, the tank should be cleaned by scraping, wire brushing, and if practical, shot blasting all interior surfaces to remove all loose rust and

deposits:

Even if the corrosion test indicates that the fuel is fit for its intended use the tank must still be tested for free water and sludge. Any water and sludge found should be removed, and tested immediately for sulphides as described. If sulphides are found, the fuel should be removed immediately and stored in a clean tank, and the polluted tank should be cleaned, as soon as possible, as outlined in paragraph 2. If no sulphides are found, all free water and sludge should be removed from the tank, even though in the first instance to do this may necessitate cleaning the tank.

Once a tank has been tested and found to be satisfactory for the storage of fuel, or cleaned to make it so, it is essential to ensure that neither dirt nor water subsequently enter the fuel. Under airfield conditions it is difficult to prevent a small quantity of water getting into bulk storage tanks, but this quantity can, and must, be kept to a minimum by adequate safeguards as already detailed. Where the presence of corrosive sulphur has been confirmed or is suspect it is essential that in addition to the normal Quality Control Standard fuel in storage must be checked, at monthly intervals, as described in para. 2.

G. ACTION TO BE TAKEN IF AIRCRAFT CONTAMINATION OR FUEL IRREGULARITIES ARE SUSPECT

Much evidence in the past has been lost or destroyed by incorrect procedures in sampling and recording incidents of contamination.

The following notes are given for the guidance of those immediately concerned in such incidents.

1. Samples must be taken at all aircraft and engine drain points. These must be collected directly into clean glass containers of not less than 1 quart size. These containers must immediately be effectively sealed and retained.
2. Where contamination is confirmed repeat sampling must be made until either the contamination is cleared or confirmed as being extensive.
3. When engine L.P. filters are removed care should be taken to collect all fuel from the filter housing into a clean glass container which should at once be sealed.
4. L.P. filter elements must immediately on removal be placed in a polythene bag and sealed to retain all moisture. On no account must these elements be handled or left to dry.
5. In the event of water being found in L.P. filter housings it is most important that the source of this is defined and checks made on all fuel tank drains.
6. A careful record should be made of each action taken and its results, this should also include details of fuel supply, method used, i.e. truck or hydrant at last uplift and the fullest possible details on any items which might indicate irregularity.
7. All samples must, on removal, be clearly and indelibly labelled with full details, date, engine number, position, hours operated, location of incident and any other data which may be relevant.

H. WATER DETECTORS FOR TESTING AVIATION TURBINE FUELS

The detection of undissolved water in fuel in the form of a suspension of very fine droplets or 'haze' can under some circumstances be very difficult by visual inspection, and certain fuel companies have developed chemical detectors to give more positive indication of suspended water.

Either of the following two such devices is recommended for use in addition to visual inspection.

(a) A "Detector Unit" developed by the Shell Thornton Research Centre consists of a small element of filter paper, sensitized with chemicals and mounted in a plastic head. This is made to fit the 'Record' taper of a standard 5 ml. hypodermic syringe.

If suspended water is present in the fuel sample, the exposed centre portion of the filter paper undergoes a chemical reaction, causing a distinctive colour change in contrast to the outer rim of the paper. This change varies with the ratio of suspended water present in the sample, detector indication ranging from 0.003% wt. to 0.01% wt. at which stage the dye-content is fully saturated.

The unit and instruction can be obtained from :

Shell Aviation Department,
St.Helen's Court,
Gt. St. Helen's Street,
LONDON, E. C. 3.

Nylon unbreakable hypodermic syringes 5 ml. size suitable for use with the Shell detector are obtainable from :

Charles F. Thackray Limited,
Park Street,
LEEDS.

(b) A "Hydrokit" developed by the Esso Research and Engineering Company is a simple "go-no go" test. It employs an extremely sensitive colour indicator calibrated for 30 ppm of water. If the indicator changes colour the sample FAILS: water concentration is 30 ppm or above. If it doesn't change colour the sample PASSES: water concentration is below 30 ppm.

The Hydrokit package consists of 25 standard jars, 25 capsules of indicator, and a set of instructions. The indicator capsules are contained in one of the jars, which also contains a desiccant to keep the capsules dry. Such a package contains everything necessary for 25 fuel samplings.

For locations where frequent testing is anticipated, a second Hydrokit package is available. It contains 25 jars, with each jar containing 25 capsules - enough for 625 samplings.

The jars may be used over and over again if due care is observed in cleaning and drying them.

The Hydrokit and instruction can be obtained from any Esso Aviation petroleum service.

J. GLOSSARY

Dissolved water is that which is soluble in fuel and which is only detectable by laboratory tests.

Suspended water is water in extremely fine droplet form which remains suspended in the fuel for periods in excess of 10 minutes.

Free water is water in such a form that it readily separates.

K. HANDLING AND QUALITY CONTROL OF WATER-METHANOL MIXTURE

In conjunction with some major oil companies the following notes have been prepared for operators' guidance.

1. Container Materials

   Containers for either methanol or water-methanol mixture should be constructed of stainless steel, glass, Monel metal or other corrosion-resistant materials which cannot affect the product.

   Plain drum steel is suitable for methanol for limited storage, but should not be used for the mixture.

   Galvanized mild steel containers should never be used.

2. Storage of Drum Stocks (Blended or Unblended)

   (a) Drums should be stored preferably under cover off the ground and on their sides with all bungs beneath the product level and in such a manner that they are visible and accessible.

   (b) They should be segregated in lots according to the batch numbers and should be used on a 'first in - first out' basis. Each batch should be prominently labelled.

   (c) A daily inspection should be carried out to check for leaks, and leaking drums should be decanted into sound drums, or the bungs re-tightened with new washers.

   (d) The drum end markings should be inspected frequently for legibility.

3. Blending

(a) Before blending both the methanol and water should be checked for compliance with Rolls-Royce Specification No. AEP-1-W/M (latest issue). After blending, check that the specific gravity is within the required range and that the product is bright and clear.

(b) It is advisable to blend only the minimum supplies necessary for a period of one or two weeks in order to avoid the risk of the mixture going off specification.

(c) All containers used during blending should be scrupulously clean and checked for freedom from solid or liquid contaminants. To prevent contaminants from entering the containers, blending should not take place in the open or in a dusty atmosphere.

4. Dispensing Equipment

(a) All dispensing equipment should be manufactured from corrosion-resistant materials, and where pumping or compressed air units are employed, a 10-micron (nominal) filter should be fitted.

(b) If hand filling from cans is being employed, delivery should be effected through a funnel fitted with a suitable corrosion-resistant screen, not coarser than 200 mesh.

5. Delivery to Aircraft

(a) The mixture should be checked for specific gravity within 24 hours before delivery; where the mixture is held in dispensers a daily check of specific gravity should be made.

(b) Dust covers on replenishing nozzles or couplings should not be removed until immediately prior to delivery and should be replaced immediately afterwards.

(c) Where over-wing filling is being employed, it is MOST IMPORTANT to ensure that the correct filler cap is opened and that water/methanol mixture is not delivered to the fuel tanks.

(d) Over-wing filling nozzles or funnels should shroud the filler orifice to prevent the entry of contaminants, and the filler cap should be removed only immediately prior to replenishing and replaced and locked immediately afterwards.

6. Markings

All containers and dispensing equipment should be prominently marked to stress the need for care in handling.

7. Safety Precautions

(a) All personnel concerned with the handling of methanol should be made aware of the dangers involved. It is extremely irritating to the eyes and skin, poisonous if taken internally, and highly inflammable. It will also strip paint surfaces.

(b) If water/methanol is spilt, either on an aircraft or elsewhere, flush generously with water and then clean up the residue.

(c) Smoking should not be permitted where methanol is used or stored.

(d) Personnel should prevent direct contact with the skin and avoid breathing the vapours. Should methanol be splashed on the skin, it should be washed off immediately, and if clothing becomes contaminated it should be changed. It is preferable for personnel handling methanol to wear protective clothing. Handling should be carried out only in well ventilated areas.

(e) If methanol should be swallowed, give a tablespoonful of salt in a glass of warm water and repeat until vomit is clear. Give two teaspoonfuls of bicarbonate of soda in a glass of water. Lay patient down in fresh air and keep warm, cover eyes to exclude light.

(f) If methanol should get in the eyes, immediately flush with water for at least 15 minutes.

(g) In both cases (e) and (f) call a doctor immediately.

L. ANTI-MICROBIOLOGICAL ADDITIVES

1. Purpose

Aviation turbine fuels contain spores of many microbial species which can propagate in the presence of water and at the correct temperature range, ideally 25 to 35 deg.C. The presence of microbiological growths can be instrumental in causing severe corrosion in the aircraft fuel tanks resulting in engine filter blockage.

The obvious solution to this problem is to prevent the fuel becoming contaminated by water during storage (see A.1.) and by routine aircraft drain checks, but there will be occasions when aircraft fuel tanks become infested with microbial growths and a biocide is required to eliminate the growths and thus prevent corrosion. In these circumstances allowing that this is an aircraft problem which may sometimes affect the engine, the treatments described in '3. Usage' are permitted subject to the prescribed limitations being maintained.

2. Description

A. Methyl Cellosolve

Methyl Cellosolve is the synonym for Ethylene Glycol Mono Methyl Ether

NOTE: Fuel to specifications D.Eng.R.D.2453 and 2454, and Australian, New Zealand and French Equivalents, contain Ethylene Glycol Mono Methyl Ether.

B. Biobor JF

3. Usage

A. Methyl Cellosolve

The use of Methyl Cellosolve incurs no flight restrictions. It may be added to the fuel in concentrations between 0.15 to 0.25 per cent by volume, the lower concentration being employed on a continuous usage or an intermittent basis to prevent contamination in known problem areas. The maximum concentration is intended to be used as 'shock' treatment at aircraft maintenance periods.

In all cases the fuel may be burned in the engine, always provided that it is not contaminated with microbial debris.

B. Biobor JF

The use of Biobor JF is permitted subject to the prescribed limitations.

It may be used on an intermittent or non-continuous basis at a a concentration in fuel not exceeding 270 parts per million (ppm) (20 ppm Boron) as a 'shock' or preventive treatment at aircraft maintenance or prescribed time intervals, e.g. three months or 600 hours. It is preferred that fuel with the additive in such concentration should not be burned in the engine, but if it is necessary to do so the volume consumed must be minimal.

Turbine fuel handling and quality control (cont.)

In cases of necessity, a continuous treatment with Biobor JF is permitted at a concentration not exceeding 135 ppm. To avoid filter blockage by solid matter which may be precipitated by the biocide, filters must be monitored and lives re-established from operator experience.

CAUTION: THERE IS A NUMBER OF 'BIOBOR' PRODUCTS: IT IS ESSENTIAL THAT ONLY THE ONE WITH THE SUFFIX 'JF' IS USED, I.E. 'BIOBOR JF'.

RECLAMATION OF GAS TURBINE OILS

Due to the increased number of approved lubricants, their admixture in service, different deterioration rates of the same type of oil from different engines, and the unpredictable nature of contamination, the problems of reclamation have become more complex.

The use of reclaimed synthetic lubricating oils is, therefore, not permissible for the operation of Dart engines, unless the reclamation procedure is approved by Rolls-Royce Limited.

Operators wishing to take advantage of the reclamation schemes now in hand should apply to Rolls-Royce Limited.

ROLLS-ROYCE SPECIFICATION FOR TYPE 1 METHANOL/WATER MIXTURE

Specification Ref: AEP-1 W/M Issue 6

Date of Issue: September 1967
(Superseding Issue 5 dated
March 20th. 1959)

1. Introduction

1.1 This specification covers the quality of the water/methanol mixture to be used, when specified, for injection into the compressor of Rolls-Royce turbo-propeller engines to restore or augment take-off power.

2. Composition

2.1 The Methanol/Water mixture shall consist of water containing not less than 36%, nor more than 38%, by weight of Methanol. This is approximately equivalent to a mixture at 60°F. (15.6°C.), of 43.8 volumes of Methanol and 56.2 volumes of water.

2.2 The methanol shall comply with the requirements of British Standard 506: 1966, or the American Federal Specification O-M-232d (Grade A). There is no technical requirement for a denaturant but, should the latter be demanded by law in any locality, the following is approved:

Pyridine, 0.5% by volume.

NOTE: The distillation range of the methanol may be affected by the presence of pyridine and if the latter is present the distillation requirment is modified to read 'not less than 95% by volume shall distill between 64.5°C. and 66.5°C'.

Under no circumstances shall other denaturants such as, for example, benzole of corrosion inhibiting oils be included in material supplied against this specification.

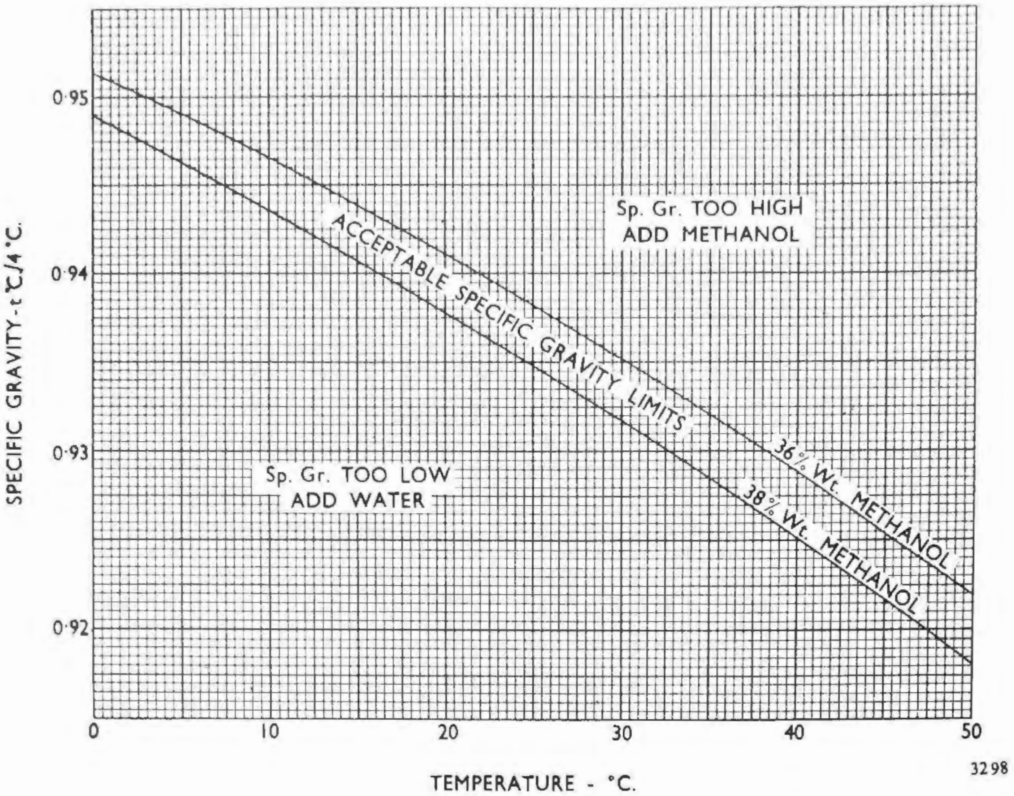
2.3 The water shall be clear, free from adventitious matter and conform to the following requirements:

2.3.1 Total Solids

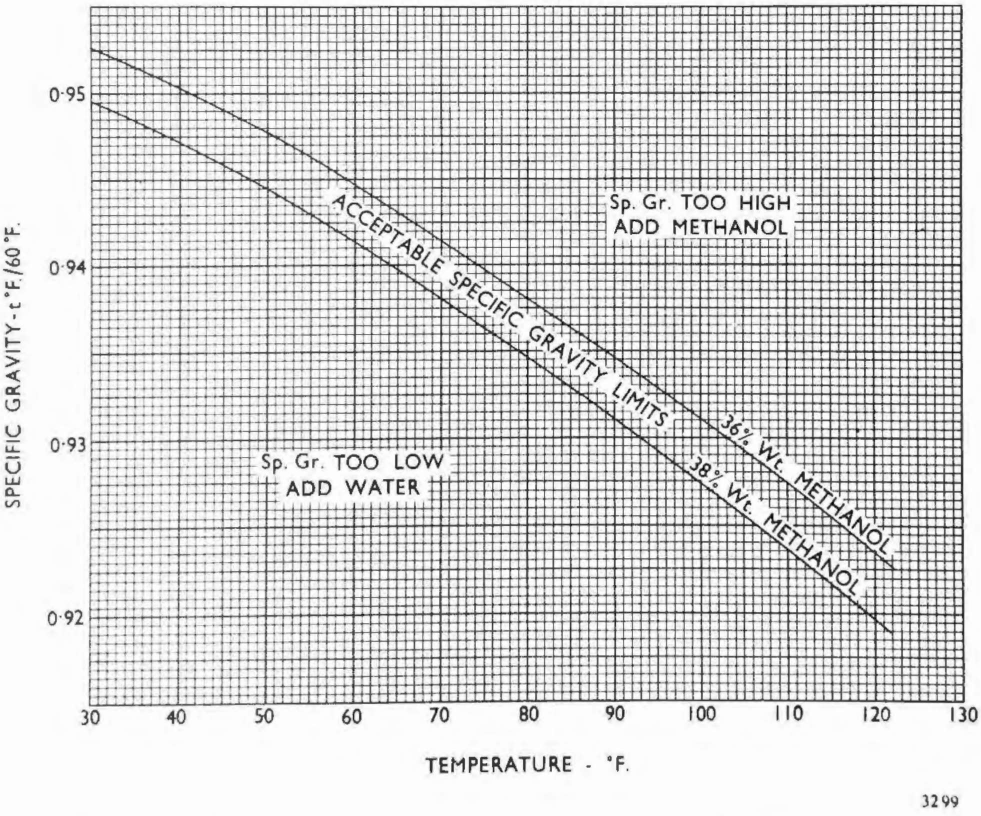
The Total Solids, when determined in accordance with Appendix 1 shall not be greater than 10 p.p.m. at 103 ± 3°C.

2.3.2 pH Value

The water, when free from carbon dioxide, shall be essentially neutral, (see Appendix 2) having a pH value not less than 5 nor greater than 7.5.



Specific gravity of water/methanol mixtures at various temperatures (centigrade scale)
Fig.1



Specific gravity of water/methanol mixtures at various temperatures (Fahrenheit scale)
Fig.2

2.3.3 Production

These requirements may be met by distillation or other methods of purification. When however, purification is carried out in the field, the quality of the water may be controlled by conductivity measurements and a silica check, in accordance with the method outlined in Appendix 4, in which case the specific counductance of the treated water shall not be more than 11×10^{-6} mhos. cm^{-1} at 20 ± $5^{o}C.$, and the silica content shall not exceed 3 p.p.m. In cases of doubt, the total solids clause 2.3.1 shall be the overriding factor.

3. Methanol/Water Test Requirements

3.1 A sample of the Methanol/Water mixture transferred to a clean glass vessel shall be clear and free from sediment and suspended matter, (see Appendix 3 for filtration requirements) and shall comply with the following requirements:

3.1.1 Specific Gravity

The specific gravity at $60^{o}F./60^{o}F.$ ($15.6^{o}C.$) of the Methanol/Water mixture shall be not less than 0.9412 ($18.8^{o}A.P.I.$), and not more than 0.9445 (18.3^{o} A.P.I.). At mixture temperature other than $60^{o}F.$ ($15.6^{o}C.$) the specific gravity must be within the limits given on the graphs attached to this specification (Fig.1 and 2).

NOTE: Due to a change in temperature upon mixing, the specific gravity must be determined when the temperature of the mixture has stabilised.

3.1.2 Total Solids

The Total Solids, when determined in accordance with Appendix I, shall not be greater than 10 p.p.m. at 103 ± $3^{o}C.$

3.1.3 Acidity

The acidity of the mixture shall not exceed 13 p.p.m.wt. (calculated as Formic Acid) when determined in accordance with the method given in Appendix 5A.

3.1.4 Field Tests

In the field, the quality of the water/methanol mixture may be controlled by conductivity measurements (para.2.3.3) and the 'Chevron Field Acidity Test' (Appendix 5B), in which case the mixture must pass the acidity test and possess a specific conductance not more than 11×10^{-6} mhos. cm^{-1} at 20 ± $5^{o}C.$ In cases of doubt the total solids clause 3.1.2 and the acidity clause 3.1.3 shall be the overriding factors.

NOTE: Conductivity and acidity are inter-related, thus mixtures found to have an acidity below 13 p.p.m. (Formic Acid), but possessing conductivities in excess of 11×10^{-6} mhos. cm^{-1} should be checked by determining the total solids content in accordance with the method given in Appendix 1.

4. Preparation and Storage of Methanol/Water Materials

4.1 Because of the volatile nature and inflamability of Methanol, the Methanol/Water mixture should be prepared on a site free from draught, direct sunlight and naked flames.

4.2 Suitable vessels shall be employed when mixing batches of Methanol/Water. See paragraph 4.3.

4.3 Storage

Water and methanol/water blends shall be stored in vessels manufactured from corrosion resistant material, e.g. stainless steel, glass or approved plastics. Mild steel containers shall not be used unless they are lined with an approved internal coating which does not affect the quality of the fluids. Because of the hygroscopic nature and volatility of Methanol, vessels containing the Methanol/Water mixture should be well sealed and stored in a cool place.

4.4 Methanol/Water mixture shall comply with the requirements of para.3 when it is introduced into the tanks of aircraft.

4.5 Notice to Operators

It must be remembered that residual quantities of Methanol/Water mixture in aircraft tanks may have been affected. If the residual quantities are sufficient to have a significant effect on the composition of the mixture resulting from the next re-fuelling, then the specific gravity of the residues must be determined and taken into consideration. Further, Methanol Mixtures can increase in acidity on storage, both in bulk and in aircraft tanks, hence acidity checks should be carried out following periods of storage. These checks may be carried out by using, either the method given in Appendix 5A, or by the 'Chevron' Field Acidity Test in Appendix 5B.

APPENDIX 1

DETERMINATION OF TOTAL SOLIDS CONTENTS OF WATER AND WATER/METHANOL MIXTURES

A clean platinum basin approximately 100 ml. capacity is heated for 30 minutes in an oven at 103 ± 3°C. and is then cooled in a desicator and weighed (W_1).

A representative sample of the fluid to be examined in thoroughly shaken and 1000 ml. are measured out in a volumetric flask. Approximately 50 ml. portions of sample are transferred to the platinum basin, each portion successively being cautiously evaporated until the whole of the 1000 ml. sample has been evaporated to dryness. Care should be taken during the performance of this test to prevent:

(a) vigorous boiling of the sample.

(b) drying out of the basin until the whole of the sample has been evaporated.

(c) ingress of foreign matter.

The basin and residue are next dried for one hour at 103 ± 3°C, cooled in a desicator and weighed (W_2).

Calculation

$$\text{Total Solids p.p.m. at } 103 \pm 3^{\circ}\text{C.} = \frac{1000\,(W_2 - W_1)}{S}$$

Where:

W_1 = weight in grams of empty basin.

W_2 = weight in grams of basin plus residue after drying at 103°C.

S = specific gravity of the fluid under test.

APPENDIX 2

DETERMINATION OF pH VALUE

The pH of the water may be determined by any suitable means e.g. electrometrically, indicator paper or liquid, and shall not lie below pH 5.0 nor exceed 7.5.

If as a result of this test the water is shown to have a pH below this limit then the following procedure should be followed:

Approximately 100 ml. of the refined water should be gently boiled in a resistance glass flask for 5 minutes in order to remove the dissolved carbon dioxide. The boiled water should then be rapidly cooled to room temperature (approximately 20°C.) and the pH value immediately re-determined.

If the pH value is still below 5.0, then contamination must be suspected and the water should be withheld and appropriate action taken.

APPENDIX 3

FILTRATION

To meet the Specification clause, 3.1 it will be necessary to filter the Methanol/Water mixture. The basic requirement for filtration is that during aircraft re-fueling operations the Methanol/Water mixture should be passed through a filter capable of removing any particles in excess of 10 micron diameter. Since filters capable of ensuring this, and which are satisfactory for use with Methanol/Water mixtures, are not readily available, it has been provisionally agreed that a filtration standard equivalent to that given by a 200 mesh gauze is an accepted alternative. If experience should prove that this standard causes trouble then it will be necessary to revert back to the basic requirement of a 10 micron standard.

APPENDIX 4

DETERMINATION OF SILICA CONTENT OF WATER (FIELD TEST)

Apparatus

Two 50 ml. Nessler glasses.

Two 5 ml. graduated pipettes (or one 2 ml. pipette and one 4 ml. pipette)

Lovibond Nessleriser

One yellow silica disc to read p.p.m. SiO_2.

Reagents

10% w/v solution of Analar Ammonium Molybdate.

2 N. Sulphuric Acid.

NOTE: Ensure that reagents are made up with silica-free pure water and stored in polythene bottles, and that any apparatus used is thoroughly cleaned immediately before carrying out the test.

Method

Fill one of the Nessler tubes to the 50 ml. mark with the sample and place it in the left hand compartment of the Nessleriser. Fill the second Nessler tube to the 50 ml. mark with the solution under test and maintain at 15 - 35°C, add 2 ml. of the ammonium molybdate solution followed by 4 ml. of the sulphuric acid solution, mix well and allow to stand for 15 minutes. Place in the right hand compartment of the Nessleriser. Hold the Nessleriser before a uniform of white light and compare the yellow colour produced with the colours in the standard disc, rotating the latter until a colour match is obtained.

APPENDIX 5

DETERMINATION OF ACIDITY

Method 5A (Laboratory)

Place 100 ml. of the sample and a few clean anti-bumping granules into a 500 ml. conical flask of borosilicate glass and boil gently for 5 minutes to eliminate carbon dioxide. Close the neck of the flask with a stopper, add 0.5 ml. of phenolphthalein indicator, prepared by dissolving 0.5g. of phenolphthalein in 100 ml. of 95% Methanol and making faintly pink by the addition of dilute sodium hydroxide solution.

Titrate with 0.1N. sodium hydroxide solution using a microburette. Calculate the acidity as formic acid from the formula:

$$\text{Formic acid, p.p.m. by wt.} = \frac{46 \times T}{S}$$

Where, T = volume in millilitres, of 0.1N. sodium hydroxide.
S = specific gravity of sample.

Method 5B ('Chevron' Field Acidity Test)

Take 100 ml. of the water/methanol under test in a clean glass vessel. Pour all of the blue solution from the plastic capsule into this sample, and swirl gently for a few seconds. Observe the colour of the whole sample against a white background:

(1) A faint blue, to blue colour indicates that the sample meets the acidity requirements of the specification.

(2) A yellow, or a yellow-green colour indicates that the sampled product is suspect.

A sample of suspect product must be tested before use by a qualified laboratory in accordance with the method outlined in Method 5A, or alternatively discarded.

NOTE: The 'Chevron' Field Acidity Test is packaged in boxes containing 100 test capsules, and is available from:

Chevron International Oil Co. Ltd.,
Bowater House,
Knightsbridge,
LONDON S.W.1.
England.

SPECIFICATION FOR ENGINE STARTING EQUIPMENT

A.P.S.31 Issue 2

1. Performance

A. Description of requirement

The equipment is required to supply electrical power for starting Dart engines.

B. Output

(1) For external starting down to temperatures of minus 30 degrees C.

The source shall be capable of supplying a starter motor terminal characteristic as shown in fig.1. The truck shall be capable of supplying an initial peak current of 1,500 amperes which will have fallen to 600 amperes after 15 seconds and will maintain this current for a further 15 seconds. This cycle can be repeated for each engine three times with a 1 minute interval between the end of one cycle and the commencement of the next.

(2) For internal starting

This is carried out using batteries installed inside the aircraft.

The voltage required at the starter and the minimum voltage for starting at minus 10 degrees C. and minus 20 degrees C. is shown in fig.1. If working on minimum characteristics the battery will be subjected to an initial peak current of 1,100 amperes which will have decreased to 500 amperes after 15 seconds and will remain at this condition for a further 15 seconds.

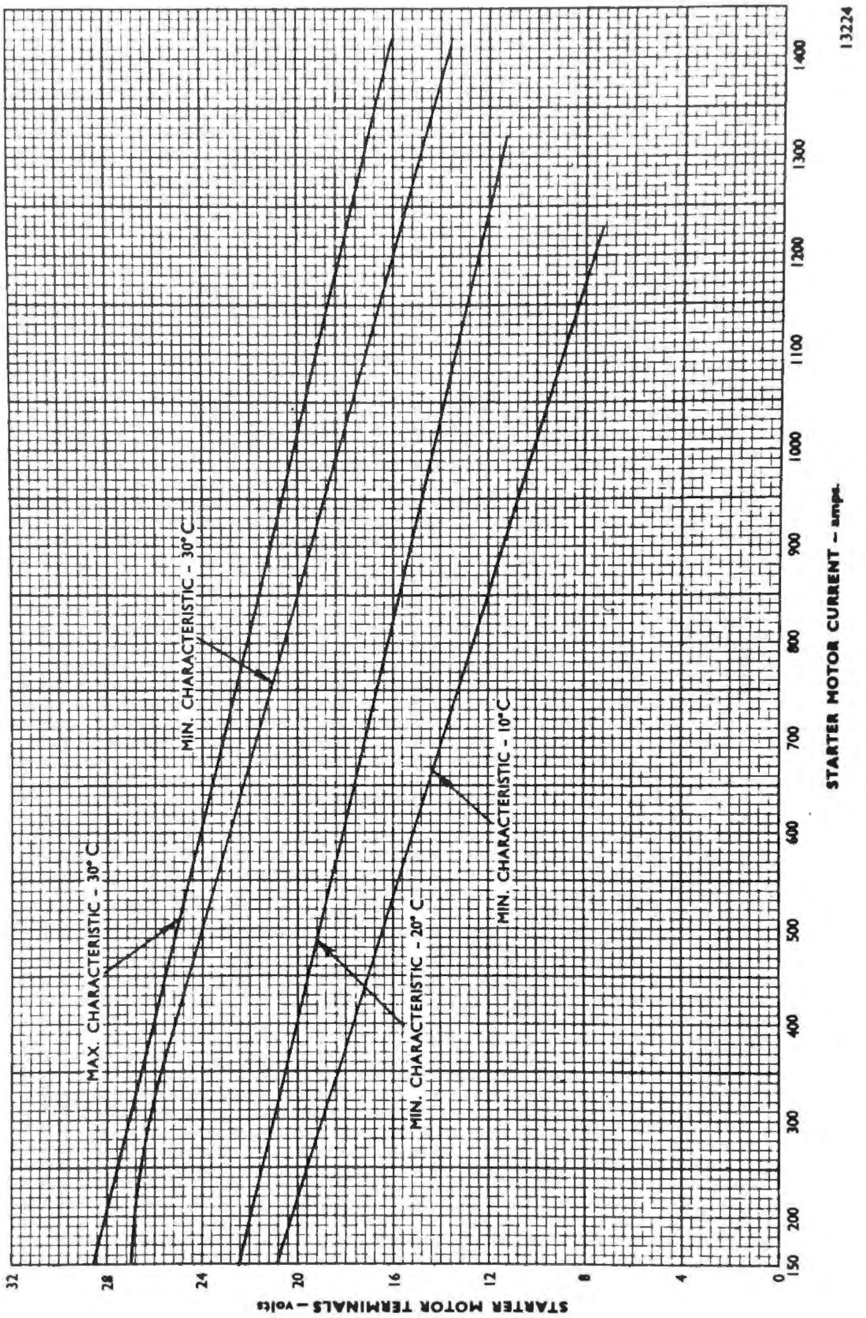
C. Control gear

(1) A single pole hand operated circuit breaker of sufficient capacity shall be fitted to the truck for protection purposes.

(2) A safety relay connected through a third core of the output cable in such a manner as to ensure that the positive main core of the cable is alive only when connected to the aircraft.

(3) There shall be low voltage and over voltage protection on all ground starting equipment to prevent starts being attempted unless the open circuit voltage lies between 28 and 30 volts. If during a start or cranking operation the aircraft plug voltage falls to below 22 volts for more than 2 seconds the low voltage cut-out should operate and break the supply.

Specification for engine starting equipment (cont.)



Starter motor requirements
Fig.1

Specification for engine starting equipment (cont.)

2. Operating conditions

The equipment is to be designed to operate under the following climatic conditions.

A. Over an ambient temperature range of minus 45 degrees C. to plus 50 degrees C. and to be capable of storage at these temperatures without ill effect.

B. In conditions up to 95 per cent relative humidity.

C. At all altitudes up to 13,400 feet.

D. In dust and sand laden atmospheres in any part of the world.

3. Fire protection

A. Flameproof requirement

It is recommended that the equipment be flameproof as defined in A.C.S.1005.

APPLICATION OF HYLOMAR JOINTING COMPOUND

1. General

Hylomar jointing compound, manufactured in light, medium and heavy grades, is specified for certain applications as detailed in 89-1. The compound has a temperature range of minus 50 degrees C. to plus 300 degrees C. (minus 58 degrees F. to plus 572 degrees F.). A minimum drying period is specified, before assembling the joint faces, to permit the carbon tetrachloride solvent in the compound to evaporate.

2. Application

A. Degrease both surfaces to be joined, using a clean cloth soaked in trichloroethylene (89-1) or other solvent of similar volatility.

B. Using a stiff bristled brush, stipple the compound thinly and evenly over both mating faces.

CAUTION: DO NOT APPLY AN EXCESSIVE AMOUNT OF COMPOUND, OTHERWISE BLOCKAGE AND CONTAMINATION OF OILWAYS AND AIR PASSAGES MAY OCCUR.

C. Allow the compound to air-dry for at least 10 minutes, then assemble the joint faces.

CAUTION: ENSURE THAT THE MINIMUM DRYING PERIOD IS ALLOWED TO ELAPSE BEFORE ASSEMBLING THE JOINT FACES OTHERWISE CORROSION OF THE FACES MAY OCCUR.

NOTE: Tackiness and adhesion to metal are sufficiently developed at the end of this period; no maximum time for air-drying is specified as long as the joints remain clean.

D. Allow a few minutes to elapse to permit the joint to settle, then torque tighten the nuts, bolts or setscrews to the specified figure as detailed in 89-3.

NOTE: The cap of the tube should always be replaced tightly after use. On no account should the compound be transferred to another container, as this will result in the evaporation of the solvent, causing difficulty in application.

STORAGE LIFE OF ENGINE COMPONENTS

1. General

The storage life of components listed in this section is conditional upon the following:

The unit has not been fitted to an engine since new or the last overhaul

The inhibiting procedure has been carried out and the correct blanks fitted

The unit is stored in a suitable container and kept in a dry atmosphere; extremes of temperature should be avoided as far as possible

Periodic inspections are made to ensure that loss of inhibiting fluid has not occurred and that no corrosion, deterioration or hardening of rubber sleeves or cable insulation has occurred

Components which are received fully pre-packed should be stored in the pre-packed condition; any special instructions on the package should be complied with.

It is recommended that during the storage period a check is kept on the modification standard of the unit and that units that have been in storage for the longest period are used first.

The ideal store house is a cool dry place with an even air temperature of 15 deg.C. and a relative humidity of 45 per cent.

2. Storage life of electrical system components

COMPONENT	LIMITATION
Hot air valve	5 years
Low oil pressure warning light switch	2 years
Low torque switch (Automatic coarsening switch)	3 years
Oil pressure transmitter	2 years
Oil temperature bulb	6 years
Starter motor	2 years
Thermocouple harness	2 years

When the storage life of a component expires, return the unit to an approved base for overhaul.

Storage life of engine components (cont.)

3. Storage life of fuel system components

COMPONENT	LIMITATION
Fuel burners	Indefinite
Fuel control unit	5 years
Fuel pump	5 years
Water/methanol control unit	3 years

When the storage life of a component expires, return the unit to an approved base for overhaul.

MAP3/3-Prn M-Da7-V

CONTAMINATION CAUSED BY LOW MELTING POINT ALLOYS

1. General

A. Contamination of a material by a low melting point alloy can, at certain temperatures, lead to intercrystalline penetration and subsequent embrittlement and cracking.

2. Contamination by cadmium plated tools

A. It is possible for deposits of cadmium to be transferred from a tool to the surface of an engine component, in the case of titanium components this could result in rapid failure of the component under certain running conditions.

B. The failure is caused by the cadmium reacting at certain temperatures with the titanium resulting in embrittlement and cracking.

C. In view of this any tool or item of equipment which is liable to come into contact with titanium must not be cadmium plated.

IDENTIFICATION OF 12-POINT SELF-LOCKING NUTS FOR LOW AND HIGH TEMPERATURE APPLICATIONS

1. These two types of self-locking nuts are geometrically similar, but with the following distinguishing features.

   A. Nuts that must be used in the hotter engine zones, in working temperatures of 230°C (446°F) to 650°C (1,202°F) are non magnetic, silver plated and partially knurled on the flange. See Fig.1.

   B. Nuts that are restricted to use in the colder engine zones, in working temperatures not exceeding 230°C (446°F) are magnetic, cadmium plated and coated with molybdenum disulphide (black). They feature a plain flange. See Fig.1.

   C. Positive identification of used nuts into these two broad groups, can only be done by individually checking each nut with a magnet.

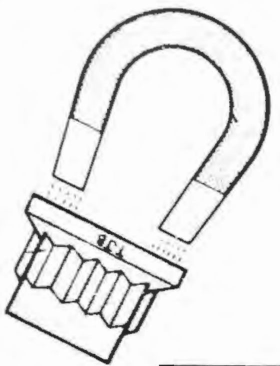
   D. Ensure that only the correct nut (as defined in the engine illustrated parts catalogue) is fitted. It must not be assumed that all low temperature zones of the engine feature magnetic cadmium plated nuts, as quite often high temperature type nuts are by design to be found in these areas.

Identification of 12-point self-locking nuts (cont.)

IDENTIFICATION OF SELF-LOCKING NUTS

FITTING OF LOW TEMPERATURE NUTS IN HIGH TEMPERATURE AREAS WILL CAUSE ENGINE FAILURE

LOW TEMPERATURE NUTS UP TO 230°C



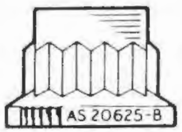
MATERIAL:- MEDIUM CARBON Ni-Cr-Mo STEEL

FINISH :- CADMIUM PLATE + BLACK COATING OF MOLYBDENUM DISULPHIDE

IDENTIFICATION:-NUT FLANGE HAS NO KNURLING

THESE NUTS ARE **MAGNETIC**

HIGH TEMPERATURE NUTS UP TO 650°C



MATERIAL:- 15% Cr - 25% Ni HEAT & CORROSION - RESISTANT STEEL

FINISH:- SILVER PLATE

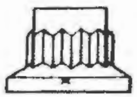
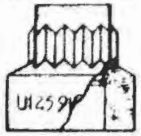
IDENTIFICATION:- NUT FLANGE IS **KNURLED**

THESE NUTS ARE NOT MAGNETIC

THESE NUTS BECOME BLACK AFTER USE

LOW TEMPERATURE NUTS ARE BLACK & HIGH TEMPERATURE NUTS ARE BRIGHT WHEN NEW BUT-

DO NOT IDENTIFY BY COLOUR AFTER USE

NUT TYPE	THREAD SIZE	ALTERNATIVE RR NUMBERS	
THESE NUTS HAVE MANUFACTURER'S CODE ONLY ON THE FLANGE			
	No 10-32	1205924	U125924
	.250-28	1205925	U125925
	.3125-24	1205926	U125926
	.375-24	1205927	U125927
	.4375-20	1205928	U125928
REGULAR NUT	.500-20	1205929	U125929
THESE NUTS HAVE PART N° & MANUFACTURER'S CODE ON THE FLANGE			
	No 10-32	1209162	U129162
	.250-28	1209163	U129163
	.3125-24	1209164	U129164
	.375-24	1209165	U129165
DEEP COUNTERBORED NUT			

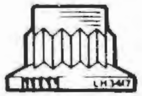
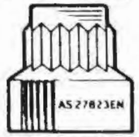
NUT TYPE	THREAD SIZE	ALTERNATIVE RR NUMBERS		SBAC N°
THESE NUTS HAVE PART N° AND/OR MANUFACTURER'S CODE ON THE FLANGE	No 8-36	1205943	U125943	AS20623
	No 10-32	1205944	U125944	AS20624
	.250-28	1205945	U125945	AS20625
	.3125-24	1205946	U125946	AS20626
	.375-24	1205947	U125947	AS20627
	.4375-20	1205948	U125948	AS20628
REGULAR NUT	.500-20	1205949	U125949	AS20629
THESE NUTS HAVE PART N° AND/OR MANUFACTURER'S CODE ON THE FLANGE	No 8-36	1209171	U129171	AS27821
	No 10-32	1209172	U129172	AS27822
	.250-28	1209173	U129173	AS27823
	.3125-24	1209174	U129174	AS27824
	.375-24	1209175	U129175	AS27825
DEEP COUNTERBORED NUT				

Fig.1

TML 5405

MISUSE OF MOLYBDENUM DISULPHIDE LUBRICANTS

Molybdenum disulphide lubricants break down above 300 degrees C. (572 degrees F.) releasing sulphur which can induce stress corrosion and premature failure of engine parts so lubricated.

Since most of the bolt materials used in the higher temperature zones of the engines are sensitive to sulphur attack it is essential that the supply and use of lubricants containing molybdenum disulphide is strictly limited to those parts for which they are specified in the manuals.

TEMPORARY MARKING OF PARTS

1. General

A. During maintenance it may be necessary when making checks to mark certain parts.

CAUTIONS: 1. CHINA CLAY BASED PENCILS, E.G. 'CHINAGRAPH' PENCILS MUST NOT BE USED.

2. GRAPHITE PENCILS GIVE CARBON PENETRATION AT HIGH TEMPERATURES AND MUST NOT BE USED. MARKS INADVERTANTLY MADE BY GRAPHITE PENCILS MUST BE COMPLETELY REMOVED BEFORE HEAT TREATMENT OR ASSEMBLY.

2. Marking media

A. The following materials are approved for the marking of all parts; refer to Chap.89-1.

(1) Pencil/crayon temporary marking.

NOTE: 'Noblot' ink pencil is the only marker available for use under water, e.g. during an ultrasonic inspection under water.

(2) Felt or fibre temporary marker.

(3) Marking ink.

(4) Electrolytic mark using EM16A electrolyte and Rolls-Royce electrolytic marking head.

B. The following marker is of a more permanent nature and should only be used on parts located in the cool sections of the engine, i.e. at temperatures not exceeding 280 deg.C. (536 deg.F.).

(1) Marlube layout fluid.

C. Any other marking media not listed must be approved by Rolls-Royce Limited before use.